ARCHIVES of OPHTHALMOLOGY

VOLUME 6 (old series Volume 63) JULY, 1931 NUMBER 1

THE METABOLISM OF THE EYE

I. PHYSIOLOGIC ASPECTS *

W. S. DUKE-ELDER, M.D.

LONDON, ENGLAND

When Prof. Yandell Henderson of Yale—one of the many people whose names are well known, and liked, on either side of the Atlantic ocean—came to England five years ago, he defined the objects of all scientific investigation in a peculiarly happy and paradoxical way, such as always lingers in the memory—"to understand, to predict, to control." Of these, the third is the last to be attained and the greatest, for unless one has first gained an understanding of the nature of basic phenomena, prediction is inaccurate and control impossible. In ophthalmology, so far as the basic facts of the metabolism of the eye are concerned, the first stage has not even been reached; there is a long way to go before one can say that one understands; it is not even possible to begin to prophesy or to direct events in the way one would choose with any hope of reaching a pragmatic result.

To a large extent, I think, this ignorance of the normal functioning of the eye, despite the enormous amount of painstaking work that has been lavished on the subject since the birth of ophthalmology as a science more than eighty years ago, is due to the method that has characterized all medicine. I have no wish or intention to deprecate the work of preceding generations, for of all branches of medical science, I think that none can claim proselytes more devoted or more brilliant than can ophthalmology. Hitherto ophthalmologists have been merely skirting round the fringes of their essential problems; they have been studying relatively gross clinical phenomena; they have been looking at the pictures —beautiful and intensely informative pictures certainly—presented by the ophthalmoscope of Helmholtz; they have been reasoning from the necessarily deformed and distorted evidence produced in the dead by the microscope of Bowman; more recently they have enlarged their field by following changes in the living with the aid of the slit-lamp of Gullstrand. Today I want to present a further and more fundamental picture. I shall consider ophthalmology from the point of view of a chemist and physiologist. I shall regard the eye, not as an organ built up of a few component parts—of three outer tunics and three inner humors—but I shall look within and beyond this to something more fundamental;

* Submitted for publication, Jan. 29, 1931.

* The Lucien Howe Memorial Lectures (1930) delivered at Harvard University.

losing the accustomed sense of magnitudes, I shall consider the infinitude of molecules and atoms, each inordinately busy traveling in its own appointed path, each running within the limits of certain laws, and controlled by complex but unalterable forces, the whole assemblage partitioned off by membranes through which, in certain circumstances, they may pass, semi-isolated but coordinated, so that they altogether comprise a teaming biochemical factory, complete in itself, but at the same time working in harmony with the larger biochemical factory of the body of which it forms a part.

TABLE 1.—*The Chemical Composition of the Vitreous Body of a Horse Compared with That of the Aqueous Humor and the Blood Serum*

	Vitreous, Gm. per 100 Cc.	Aqueous, Gm. per 100 Cc.	Serum, Gm. per 100 Cc.
Water	99.6813	99.6921	93.3238
Solids (dried at 100 C.)	1.1087	1.0869	9.5362
Total protein	0.0652	0.0201	7.3692
Albumin	0.0077	0.0078	2.9557
Globulin	0.0115	0.0123	4.4135
Mucoprotein	0.0211	—	—
Residual protein	0.0250	—	—
Fibrinogen	Traces	Traces	Present
Immune bodies	Traces	Traces	Present
Ferments	Traces	Traces	Present
Fats	0.007	0.004	0.13
Cholesterol	0.0005	Traces ?	Present
Nonprotein nitrogen	0.0264	0.0236	0.0239
Total nitrogen	0.0301	0.0268	—
Urea	0.029	0.028	0.027
Amino-acids	0.030	0.029	0.035
Lactic acid	0.019	0.205	Present
Creatinine	0.001	0.002	0.002
Sugar	0.0973	0.0983	0.0910
Sodium	0.2731	0.2787	0.3351
Potassium	0.0192	0.0189	0.0201
Calcium	0.0068	0.0062	0.0101
Magnesium	0.0020	0.0026	0.0028
Chlorine	0.4168	0.4371	0.3664
Phosphorus (inorganic)	0.0031	0.0033	0.0030
Sulphur (inorganic)	0.0062	0.0061	0.0058

Probably the most basic question in the whole of the metabolism of the eye is the origin and nature of the intra-ocular fluid. I say "intra-ocular fluid" for I think that the "aqueous humor" is a term that has an anatomic rather than a physiologic connotation; for the fluid in the chambers of the eye is the same as that contained within the tissue spaces, within the uveal tract, within the cornea and within the vitreous body. To the question, What is this fluid? the best answer is contained in table 1. A study of the figures in this table shows that the intra-ocular fluid is made up of all the constituents of the blood plasma, but in certain proportions. These constituents can be divided into three categories: (1) large molecules of colloids, such as the proteins, which are present in the intra-ocular fluid only in traces, (2) small molecules of substances in true solution which are not ionized, such as sugar, and which are

present in approximately equal amounts, and (3) small molecules of ionized salts the positively charged cations of which, such as sodium, are present in greater concentration in the intra-ocular fluid, and the negatively charged anions, such as chloride, which are present in smaller concentration.

What does all this mean? If these figures are analyzed, it is found that they conform with extraordinary exactitude to the postulates required by a thermodynamic equilibrium. The whole body is divided into cells, each separated by membranes from its neighbors, and even within the cell itself there is a complexity of potential membranes. All the active constituents of the body are dissolved in watery solution, and hence it follows that all the activity which takes place, and all means of communication between the individual cell units, must necessarily resolve itself into a question of a passage of dissolved substances through membranes. The matter, however, is not so simple as it may appear at first sight, for the membranes, as a rule, allow only the smaller molecules to pass through them and keep the larger ones behind. This provides one means of complication. Moreover, each molecule of salt in solution is broken up into two ions, each of which carries an electric charge—the one a positive charge and the other a negative. Since, therefore, a free diffusion of all ions equally is precluded by the large size of some of them, this rearrangement and difference in concentration at once involves the development of hydrostatic, osmotic and electrostatic forces. Stability and equilibrium can be reached only when all these forces are made to balance, the one compensating for the other. It is the interaction and rearrangement of these forces that is necessary to prevent the occurrence of an explosion, as it were, that constitutes a thermodynamic equilibrium.

It is through the membrane formed by the capillary wall that all vital changes associated with the interchange between the blood and the tissues take place. The mechanism can be pictured by a scheme like the following, in which I shall presume, for the sake of simplicity, that the blood possesses only two kinds of molecules: large molecules (protein, such as sodium albuminate), the colloid part of which cannot get through the membrane, and smaller molecules which can pass through it (table 2). Some of the latter are broken up into particles which are ionized and carry an electric charge (salt), and some which, being nonelectrolytes, are not thus broken up (sugar). When one tries to establish connection across the membrane, the negatively charged proteinate (P) is held back, and with it, for electrostatic reasons, some of the positively charged sodium ions will be retained also (z). So far as the diffusible ions are concerned (NaCl), Donnan has shown that in order to attain a state of equilibrium, they must obey certain conditions by which the products of their concentrations are equal on both sides

of the membrane; that is, $y\ (y + z) = x^2$ or $y^2 + yz = x.^2$ It follows, since there are more positively charged diffusible (sodium) ions in the blood $(y + z)$ than there are negatively charged (y), that there must be more negatively charged chlorine ions in the aqueous humor (x); i. e., x must be greater than y. The sugar (S) which, not being ionized and carrying no electric charge, is not subject to those electrostatic constraints is free to distribute itself equally between two fluids. Such a fluid is termed a dialysate.

When one examines how the chemical constitution of fact fits in with the requirements of theory one gets a correspondence more close than that attained by any biologic relationship of which I am aware. For example, I have found that while the sugar in the arterial plasma is 0.158 Gm. per hundred cubic centimeters and in venous plasma 0.133 Gm., that in the aqueous plasma is 0.151 Gm. per hundred cubic centimeters, which approximates the value which must of necessity be found in the capillaries. Again, to take an ionized substance, the concentrations

TABLE 2.—*Classification of Molecules Found in the Blood* *

Blood Plasma I		Intra-ocular Fluid II	
(z)	P^-	Na^+	*(x)*
(z + y)	Na^+	Cl^-	*(x)*
(y)	Cl^-	S	*(s)*
(s)	S		

* Roman lettering denotes ions; italics in parentheses denote concentrations, or (more correctly) activities.

of normal sodium in the aqueous and in the blood are as 121 : 145, while those of the chlorine similarly expressed are as 123 : 103. The concentration of negatively charged chlorine in the aqueous is the greater, and the concentration of positively charged sodium in the blood is the greater; and when the product of the ions of the two fluids is estimated, which theoretically should be equal, the figure $148.83 = 149.35$ is obtained, an exceedingly close approximation for any biologic estimation.

This peculiar distribution of chemical substances must involve definite osmotic, hydrostatic and electrostatic forces which should combine to equilibrate each other. Does the physical equilibrium fulfil the requirements of the chemical one? The differences in electrical charge imply a difference in electrical potential between the two fluids, and if this is measured galvanometrically by inserting one electrode into the jugular vein and the other into the chamber of the eye, this difference is obtained. Furthermore, the osmotic pressure of the intra-ocular fluid should correspond to the precise value necessitated by the peculiar distribution of ions which have just been considered, and, in addition, a pressure

equilibrium must be established on either side of the capillary walls so that the tendency for fluid to travel from the blood stream to the chambers of the eye will be exactly neutralized by an equal and opposite pressure in the opposite direction—that is, the hydrostatic pressure in the capillaries must be equal to the sum of the intra-ocular pressure and the difference in osmotic pressure between the two fluids. To determine this I measured the osmotic pressure of the intra-ocular fluid in the manner shown in figure 1. Intra-ocular fluid was put into the cell *B*

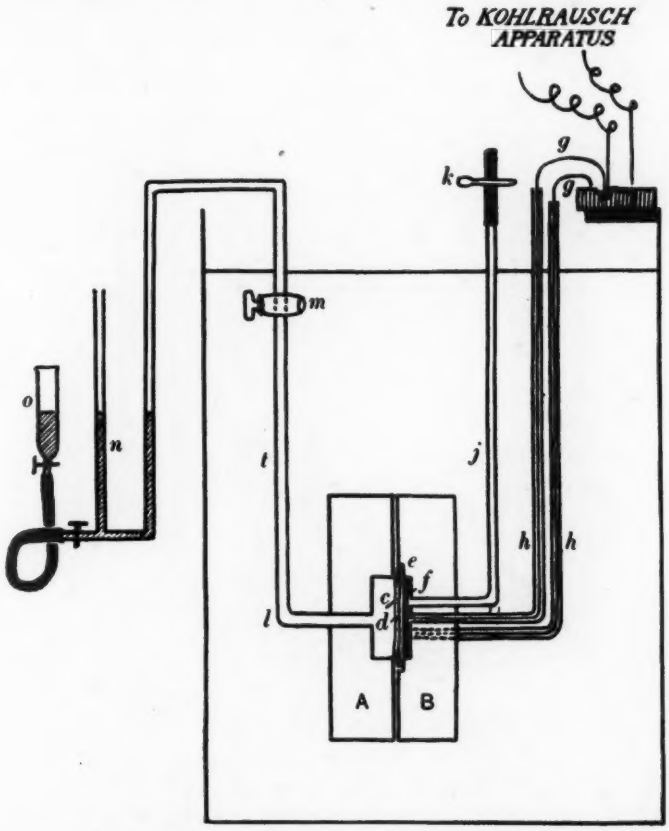

Fig. 1.—Micro-osmometer for intra-ocular fluids. Blood is put into the cell (*A*) and aqueous humor into *B*, the two being separated by a cellophane membrane (*c*) supported by wire gauze (*d*). The aqueous cell is filled through the tube (*j*) and the conductivity can be taken through platinum electrodes (*f*) which are connected (*hg*) to the Kohlrausch apparatus. The pressure is read off under constant volumetric conditions by the manometer (*on*).

and plasma into the cell *A*, the two being separated by a cellophane membrane; the conductivity was measured by the Kohlrausch apparatus before and after the experiment, which gives an exact record of any change in the dissociated materials. The sugar was estimated before

and after, which gives an indication of any change in the concentration of the nondissociated materials, and the difference in colloid concentration was read off in terms of pressures on the manometer. It was found that the osmotic pressure of the intra-ocular fluid corresponded precisely with that of a dialysate of blood serum, and that it was less than that of the plasma by 30 mm. of mercury.

The next problem was to determine the blood pressure in the eye. The arterial pressure was measured by inserting a micropipet into the retinal artery as illustrated in figure 2. It is a ticklish procedure, but under the tutelage of that brilliant physiologist, Professor Richards,

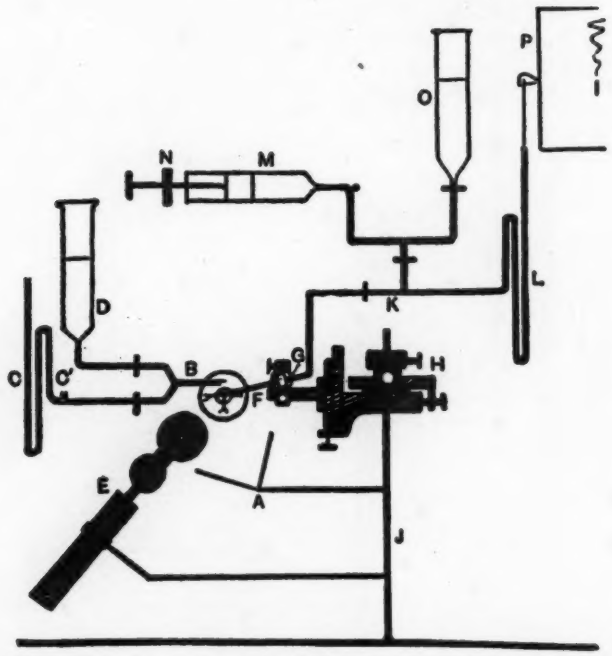

Fig. 2.—Micromanometer for determining pressure in the retinal artery. The animal's head is clamped in *A*, and the eye (*F*) is regarded through an ophthalmoscope (*E*). The pressure in the eye was kept at a normal level by the reservoir and manometer (*B*, *C* and *D*). The micropipet, which is manipulated by *H*, is connected by tubing to a manometer (*L*), the pressure being altered by a syringe (*M*), and the system being filled with a solution of methylene blue through the reservoir (*O*).

who performed similar experiments in the kidney, and after wasting a year and an almost infinite number of cats, I obtained reliable measurements of 64 and 88 mm. of mercury for the diastolic and systolic pressures. The pressure in the intra-ocular veins was measured in a similar manner and found to be about 2 mm. of mercury, above the intra-ocular pressure, and by inserting a pipet (fig. 3) controlled under

the dissecting microscope into the intrascleral veins of the dog as they left the eye (fig. 4), the pressure was found to be from 1 to 2 mm. of mercury above the intra-ocular pressure. The capillary pressure has never been adequately measured, nor would it seem possible to do so, since any intra-ocular or extra-ocular manipulation at once alters its value. But when one remembers that the tissue-pressure in the eye is from 20 to 25 mm., when one recalls the method of breaking up of the ciliary arteries into extremely wide capillaries with little or no arteriolar intervention, the physiologic constriction of the exit veins, and the fact that the whole system is confined under considerable tension in a feebly distensible case thus approximating the circulatory

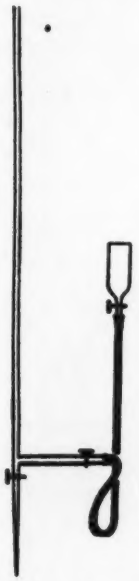

Fig. 3.—Micropipet for measuring the pressure in intrascleral veins.

mechanics to those of a system of rigid tubes—when one remembers these points, while definite figures are apt to give a wrong impression of what is an indefinite and ever-changing quantity, I think that one is quite safe in postulating a hydrostatic pressure in the arteriolar end of the capillary bed of about 50 mm. of mercury.

It is seen, then, that the physical part of the equilibrium is exactly obeyed. Moreover, in abnormal conditions changes take place in the aqueous humor exactly in terms of the same equilibrium. An alteration may be brought about by two conditions: first, by altering the permeability of the capillary walls so as to allow more substances to pass through from the blood; second, by altering the composition of the blood so that different materials are available for this. In the first case if the capillary permeability is increased, as by a dilatation

of the walls, a greater amount of colloids will get into the eye, and thus an albuminous or plasmoid aqueous is formed. Here, since the electrostatic stresses between the two fluids are now lessened, the concentration of the positive ions increases while that of the negatively charged ions diminishes, the osmotic pressure and the electrical potential fall, the concentration of hydrogen ions rises, and the pressure of the eye increases (fig. 5). This always occurs in such a way that a perfect thermodynamic equilibrium is continually maintained no matter how the alteration in capillary permeability is brought about, whether by processes so divergent as a simple paracentesis or an inflammation of the eye.

In the alternative case, if the composition of the blood is altered, the constitution of the aqueous humor alters again according to thermodynamic laws. Large molecules injected into the blood even in abnormal concentration will not find their way into the eye except in

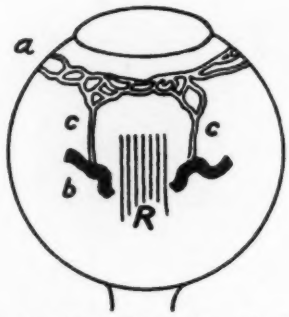

Fig. 4.—Scleral veins of the dog. The veins of the circle of Hovius (*a*) lead by means of communicating branches (*c*) to the vortex veins (*b*), which issue from the eyeball from either side of the rectus muscle (*R*).

traces. Thus dyes like trypan blue or congo red do not enter the aqueous humor, and the difficulty of facilitating the entrance of drugs like the large moleculed organic preparations of arsenic is thus explained. To a large extent this accounts also for the therapeutic value of a paracentesis, which, by increasing the capillary permeability, allows the more ready passage of substances of this nature. Further, if positively charged cations are added to the blood they enter the eye only with difficulty. The basic dyes, such as neutral red, methylene blue (methylthionine chloride, U. S. P.), cresyl blue, fuchsin and others, as well as metallic ions such as sodium, mercury or bismuth, come under this category. On the other hand, negatively charged anions enter readily, dyes like eosin, chrysolin, orange G, and anions such as iodides, chlorides, bromides and organic anoidal substances such as salicylic acid. It will be realized that this is of considerable importance pharmacologically; but in any case, it is evident that what used to be called the "selective

permeability" of the ciliary epithelium, and which used to be cited as evidence of its secretory activity, is a purely physical process determined by thermodynamic laws.

It must be remembered that any such equilibrium is by no means static, but is essentially dynamic. I have frequently been misquoted as expressing the opinion that the aqueous humor is stagnant; such is far from being the case, as is patently evident from clinical experience and is readily demonstrated physiologically. Apart from the metabolic interchange which goes on throughout the entire vascularized tissues of the eye, there is a pressure circulation impounded on the aqueous humor by changes in external pressure. It will be remembered that in the ordinary course of events the pressure in the exit veins is higher

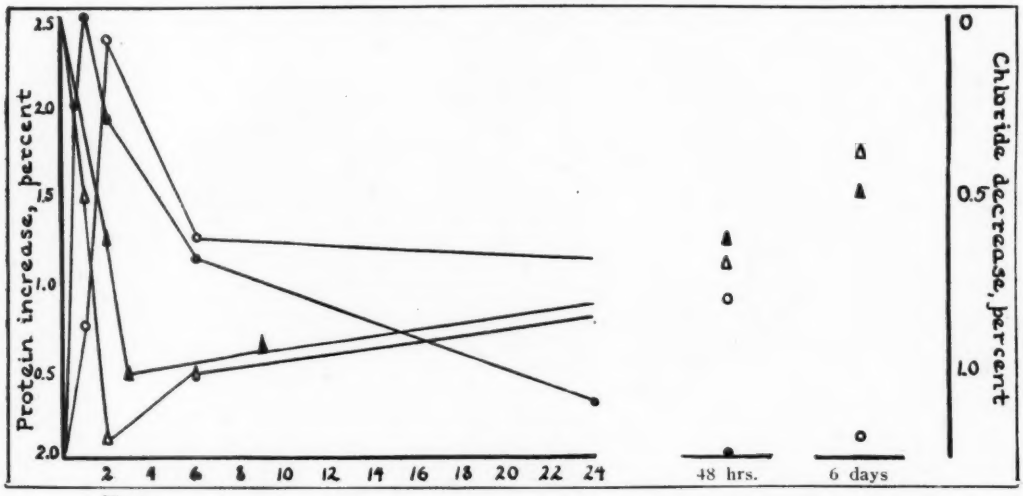

Fig. 5.—Reciprocal relation between the concentration of proteins and chlorides in the eye after paracentesis.

than the intra-ocular pressure (fig. 6*A*); but I found that when the intra-ocular pressure was raised this relationship was reversed (fig. 6*B*). Thus suppose the intra-ocular pressure were raised to 30 mm. of mercury, the veins as they leave the eye are compressed; the blood is banked back until the vis-a-tergo from behind raises the venous pressure sufficiently to maintain the circulation; at this point the pressure in the vein inside the sclera is just over 30 mm. of mercury, and that in the sclera, i. e., the canal of Schlemm, is 29 mm. of mercury. Aqueous can therefore flow in the direction of the arrow directly from the anterior chamber into the canal of Schlemm, its passage through the trabeculae being aided by the osmotic pull of the colloids in the blood serum.

Since the loss of aqueous will lower the pressure of the eye, the canal of Schlemm therefore acts as a delicately adjusted safety-valve to maintain the intra-ocular pressure at a constant level; and at the same time the mechanism here seems to maintain a through-and-through circulation of fluid, for if the cause of the increase of pressure is removed, more fluid will dialyze from the capillaries to take the place of that which is lost. During the whole of life such pressure changes are continually taking place. The pulse beat provides a change of pressure of from 1.5 to 2 mm. of mercury (fig 7), and the respiratory excursion one of 5 mm. of mercury. It will be remembered that there is a regular automatic action of blinking occurring in each individual with a definite rhythm about every two minutes. This raises the pressure by 5 mm. of mercury (fig. 8). A contraction of the plain muscle of Müller (in animals) also produces a definite increment of pressure (fig. 9.). It is

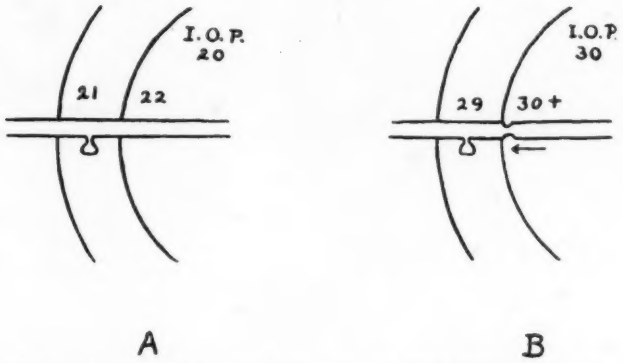

Fig. 6.—The relation of the venous pressure to the intra-ocular pressure. At *A* the pressure level is normal; at *B* the intra-ocular pressure is raised from 20 to 30 mm. of mercury.

to be remembered, of course, that the latter action is much more pronounced in the dog than it is in man. Contraction of the recti muscles also gives a definite rise of the pressure of the eye. Figure 10 shows the rise obtained on their contraction by the injection of choline into the blood stream (an interesting phenomenon the significance of which I have dealt with elsewhere); contraction of the orbicularis gives a much higher rise (fig. 11).

The picture of the intra-ocular fluid that I should like to suggest is as follows: On either side of the capillary walls there is a balancing thermodynamic equilibrium comprised of complex but well determined chemical, hydrostatic, osmotic and electrostatic forces. Around this level the mutually compensating forces are continually fluctuating, and in any capillary they will determine a flow of fluid outward at one moment and inward at another, accompanied by a diffusion outward or inward

of diffusible substances according to their several differences in concentration and determined by the nature of their electric charge, while the whole is subject to a readjustment depending on the colloid impermeabilities. This fluid percolates through all the structures within the sclera, through the stroma and the cellular elements of the ocular tis-

Fig. 7.—The blood pressure and intra-ocular pressure of the dog, the former taken by a mercury manometer and the latter by an optical manometer. The large waves represent respiratory excursions involving a change of pressure of 5 mm. of mercury. The smaller ones represent pulse beats involving a change of from 1.5 to 2 mm. of mercury in the eye.

sues, through the substance of the cornea, and eventually through the endothelium and epithelium lining the anterior and posterior chambers, filling up these cavities. Throughout its passage it is modified by meta-

bolic activity and by the stresses to which it is exposed; at all points in its course between each cell and between the interfaces within each cell, fresh membranes or potential membranes have to be traversed, each involving a new system of forces with the corresponding adjustments which these entail, and each necessitating a fresh state of thermodynamic equilibrium. While this reciprocal interchange occurs throughout all

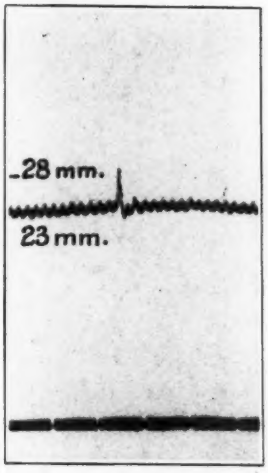

Fig. 8.—The intra-ocular pressure. Optical manometer record representing the pressure effect of a blink conditioned by touching the cornea lightly with a hair.

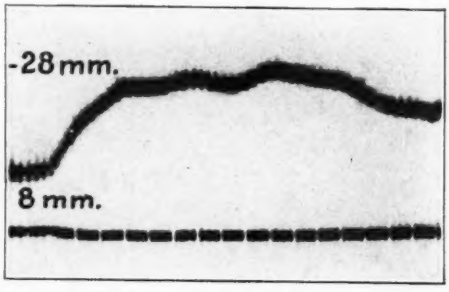

Fig. 9.—Intra-ocular pressure of a dog immediately after exsanguination by stimulating the cervical sympathetic nerves. The rise in pressure is due to a contraction of the plain muscle of the orbit (optical manometer).

the tissues of the eye, circulatory conditions to a less extent, and the influence of muscular activity to a greater extent, will determine a slow through-and-through circulation of fluid through the chambers of the eye, which will find its exit mainly by way of the canal of Schlemm, while differences of temperature within the anterior chamber itself determine an internal thermal circulation.

The aqueous humor cannot be a secretion. A secretion is the elaboration of one substance from a parent substance with the expenditure of some energy, this energy being supplied by the secretory cells. It matters not what the energy may be—chemical energy, extended in the elaboration of new substances as in the specific proteins of the lacrimal

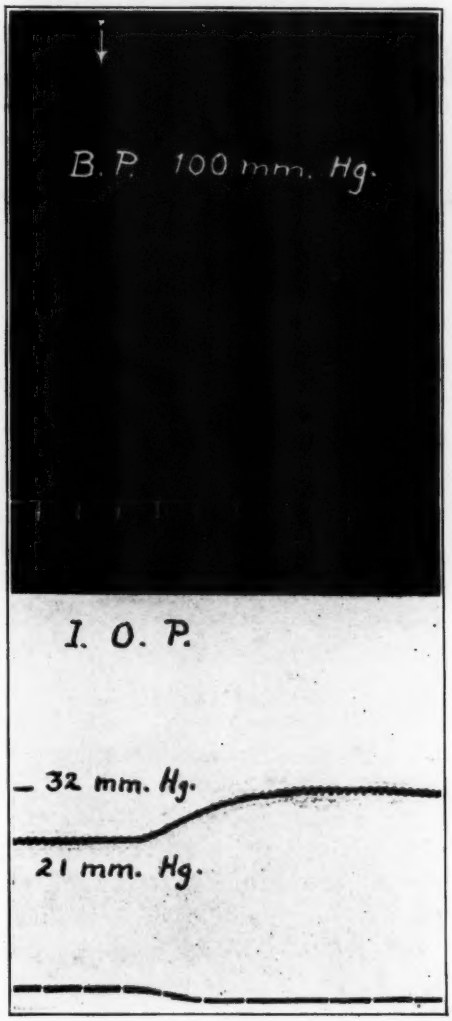

Fig. 10.—Intra-ocular pressure of the dog taken with an optical manometer showing the rise of pressure obtained on the intravenous injection of choline due to the contraction of the recti muscles. The blood pressure (upper curve) was kept artificially constant.

secretion; hydrostatic energy, as the secretion by the salivary gland of fluid at a pressure above that in the carotid artery; osmotic energy, as in the secretion of urine by the kidney of molar concentration from

blood which is 0.3 molar; or electrical energy, as by electrical fishes. The aqueous humor is in complete thermodynamic equilibrium with the capillary blood, and in its formation no energy, chemical, hydrostatic, osmotic or electrostatic, is expended. Nor is it a transudate from the blood. This is disproved by the single fact that it contains an excess of chlorides. It is a small fact which escaped the attention of early workers. But in the whole of scientific research there is nothing more important than to "treasure our exceptions," for almost invariably they lead to results vastly more important than the observations which go according to plan. With this excess of chloride present there is one of two alternatives: either there is a gland in the eye secreting chlorides, or the aqueous humor is a dialysate.

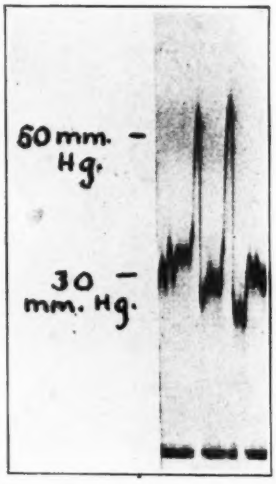

Fig. 11.—Intra-ocular pressure of the dog. Optical manometer record showing the rise of pressure resulting from stimulation of the facial nerve.

The fluid of the eye therefore resembles the fluid of the tissue spaces generally, both in its origin and in its circulation, with the reservation that, owing to the relative impermeability of the capillaries, it is practically free from protein. The capillaries vary in their degree of permeability all over the body, and their peculiar impermeability in the eye seems to be a simple and beautiful adaptation to keep the intra-ocular fluids optically homogeneous, and to ensure the necessary consequence of a high intra-ocular pressure to keep the component parts of the optical system in place.

I would divide the whole of ocular physiology into four such equilibria as these: (1) the equilibrium between the blood plasma in the capillaries and the intra-ocular fluid; (2) the equilibrium between the intra-ocular fluids and the vitreous body; (3) the equilibrium

between the intra-ocular fluids and the lens; (4) the equilibrium between the blood plasma in the choriocapillaris and the sensory epithelium of the retina.

Now that the first equilibrium has been considered, the others can be dealt with more rapidly. A chemical examination of the vitreous body (table 1) shows that it is made up of all the constituents of the aqueous humor in corresponding proportions with the addition of two specific colloid constituents of ectodermal origin: a mucoprotein and a second protein substance, which for want of a better name I am call-

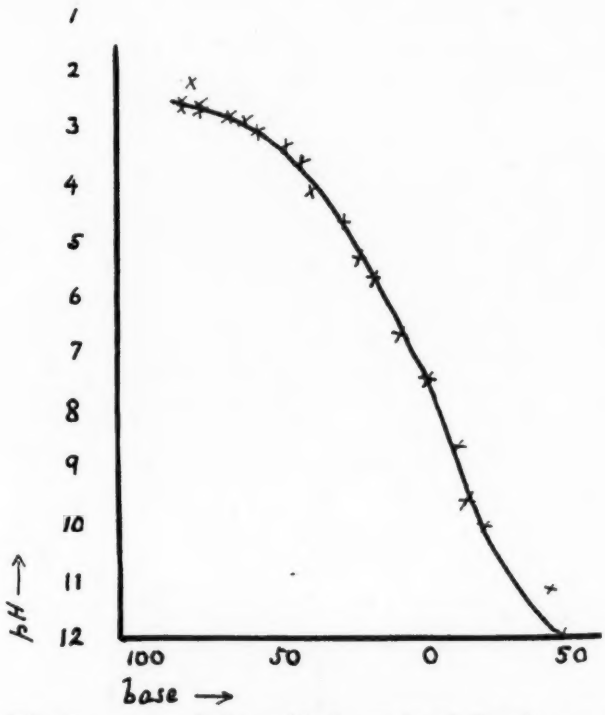

Fig. 12.—Titration curve of the residual protein of the vitreous gel. Equivalents of base bound by 1 Gm. of residual protein.

ing the "residual protein." The mucoprotein is a compound of mucoitin sulphuric acid B, and contains chitosamine as a carbohydrate radical. The only other places wherein it occurs, to my knowledge, are the cornea and the Wharton's jelly of the umbilical cord. It will be noted that these are both transparent tissues, and it seems that the function of this material is the maintenance of optical transparency. The residual protein has the following elementary composition: carbon, 44.46 per cent; hydrogen, 6.415 per cent; nitrogen, 12.21 per cent; ash, 3.825 per cent, including phosphorus, 0.12 per cent and sulphur, 0.675 per cent. Its chemical nature is further elucidated by a study of its "titration curve"

which determines its behavior when it is equilibrated with varying amount of acids and alkalis. Figure 12 shows that in these conditions it combines both with acids and alkalis in a way characteristic of protein substances. Its most noteworthy property, however, is its enormous potentiality for the formation of gel, which it is able to accomplish in a concentration of only 0.025 per cent; this power is unique, so far as I am aware, in the organic world, except as it is exhibited in the body of the jelly-fish.

The ultra-microscopic examination of the vitreous body (fig. 13) and a study of its physical properties demonstrate beyond doubt that it is, in a fresh and healthy state, a simple and homogeneous jelly, or gel, with no structure apart from the arrangement of its molecules into linear micellae; that the fibrillar appearances seen histologically

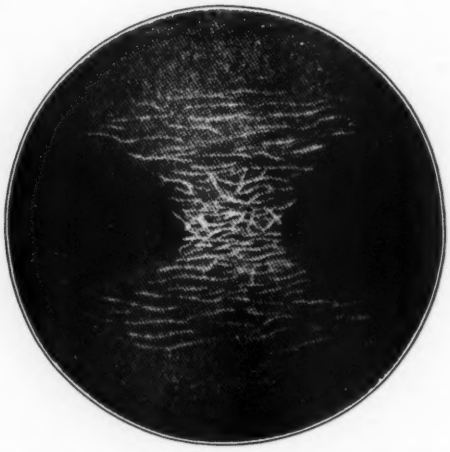

Fig. 13.—Vitreous body of rabbit six hours after death as seen by the ultramicroscope.

by the microscope are artefacts of coagulation, and that the membranous appearances seen clinically by the slit-lamp are similarly optical artefacts. When it is equilibrated with sulphuric acid and water mixtures in vacuo, its capacity for combining with water at different vapor pressure can be assessed from the change in weight which its suffers (fig. 14); and from the results obtained from extended experiments along these lines, a vapor pressure isotherm can be constructed (fig. 15). This shows that it is an elastic turgescible gel, capable of swelling and shrinking. Further, a study of its various reactions shows that, within the limits compatible with life, it tends to swell if the concentration of hydrogen ions is decreased, and to shrink if this concentration becomes larger; while, if its metabolism is upset, the whole gelatinous structure tends to break down, the vitreous body turning fluid and the residual protein

material becoming thrown out from its combined state into coagula, forming fibers and strands and membranes such as are apparent in the clinical pictures of vitreous opacities.

Here, then, is the second equilibrium. Two special colloid substances are secreted by the surrounding ectoderm, each having a special function of their own; these are percolated by the common intra-ocular fluid which enters into physicochemical combination with them, and the result is the formation of a gel. Always between the two, the intra-ocular fluid and the vitreous body, a continuous thermodynamic equilibrium exists, on the conditions of which depend events like the swelling of

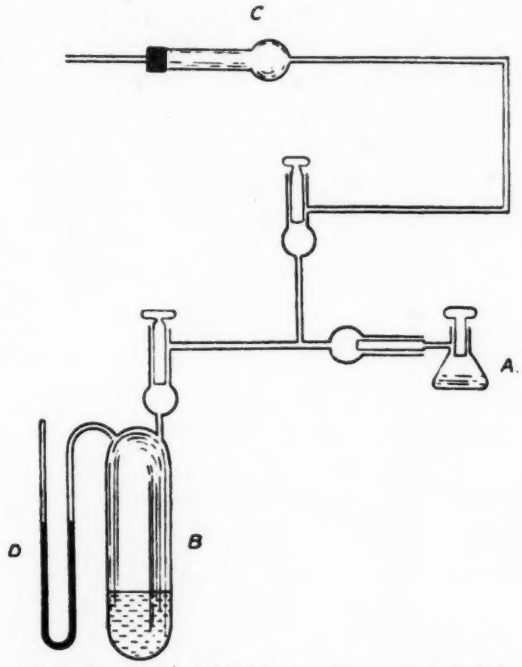

Fig. 14.—Apparatus for determining the vapor pressure of the pure proteins of the vitreous body. The vitreous is put into the weighed bottle *A*, and the apparatus is exhausted to a vacuum through the calcium chloride tube *C*, the extent of the vacuum being measured by the manometer *D*. In *B* is a mixture of water and sulphuric acid of known vapor pressure. During the process of establishment of equilibrium, air is periodically admitted through *C* and the weight of vitreous determined.

the vitreous body and the development of hypertension, or its shrinkage and the development of lowered tension, or its break down into a fluid and the formation in it of opacities; while superimposed on this, and dependent to a large extent on it, is the internal metabolic activity of the vitreous body on the efficiency of which depends its continuance as a homogeneous, solid and transparent mass.

The third equilibrium is that between the intra-ocular fluid and the lens. In this case some additional stresses are in question. To a certain extent, the lens forms a separate physicochemical mechanism semi-isolated from the remainder of the eye; its chemical composition is widely different from that of the intra-ocular fluids, to which, indeed, it may be said to bear a relationship showing some points of analogy with the relationship between the red blood corpuscles and the plasma. Corres-

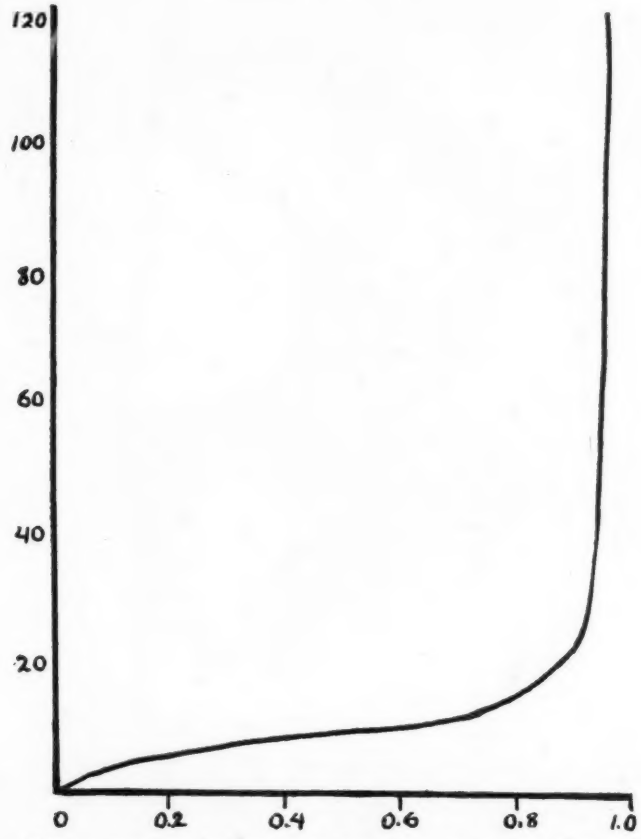

Fig. 15.—Vapor pressure isotherm of the vitreous body. The ordinates show water absorbed in millimols; the abscissae, relative vapor pressure.

ponding to this, the osmotic pressure of the lens is considerably higher than that of the aqueous by which it is surrounded; it is, in fact, higher by an amount approximately equal to a 0.3 per cent physiologic solution of sodium chloride. Owing to the force exerted by the elastic capsule, the internal tension of the lens is kept at a higher level than that of the remaining tissues of the eye; and therefore it follows that the osmotic tendency for fluid to enter the lens is counterbalanced by the opposing force exercised mechanically by the elasticity of the capsule

favoring the hydrostatic diffusion of fluid out of the lens. Superimposed on the normal thermodynamic equilibrium, there is, therefore, a constant expenditure of osmotic work acting against the filtration pressure generated by the elasticity of the capsule. The effects of the disruption of these forces constitute one of the factors in the etiology of cataract.

A delicately balanced equilibrium between the intra-ocular fluids and the lens on either side of the membrane formed by the capsule of the lens is obtained. The story, however, does not end here. The same combination of two sets of circumstances is present as is found in the vitreous body. There is first the outer equilibrium, and here again it is to be noted that the two great factors in its derangement which are of greatest importance are an alteration in the concentration of the hydrogen ions and an alteration in the concentration of salts—both of these lead to swellings and shrinkages and disorganization of the vitreous body, and both of them lead experimentally to the formation of opacities in the lens. The second set of circumstances is the internal metabolism. It has been shown that, in addition to the presence in it of enzymes, the metabolism of the lens is subserved by an internal autoxidation system, one of those very interesting and widely occurring mechanisms by which a chemical reaction is maintained in a state of constant and balanced activity, so that a continual reciprocal process of oxidation and reduction is carried on without any mediation of the gases of the blood stream. In this mechanism in the lens, glutathione acts as a hydrogen donator and β-crystallin acts as a thermostable residue, and it has been shown that an upset of their reversible interaction is a constant accompaniment of the development of cataract. This again is essentially and primarily dependent on the state and the conditions of the outer equilibrium.

The fourth equilibrium can be dealt with rapidly. The inner cerebral layers of the retina are nourished by dialyzation from the retinal vessels just as are the other ocular tissues, with the reservation that, provided as these vascular channels are with insulating perivascular glial sheaths, the cerebral type of circulation is maintained. But the sensory epithelium of the retina receives its nourishment by dialyzation through the more distantly placed vessels of the choriocapillaris. Experimental evidence has been brought forward that a local upset of this process produces a derangement of the physicochemical activity of the percipient elements of the retina such as is apparent clinically as a scotoma, while a disturbance of a different character seems to enter into the etiology of detachment of the retina.

This, then, is the picture I would present. Do not misinterpret me by crediting me with the suggestion that thereby the physiology of the eye is explained. It is almost certainly true (and few will deny it) that the body is a physicochemical mechanism, and consequently it would

seem to follow that a physicochemical method is the only one that can legitimately and rationally elucidate its activities. This one may think; but still more certainly one knows that the chemistry or the physics at one's command no more than touches the fringe of the universe of natural phenomena. It would be dangerous to delude oneself that there is any physiologic process at all, with its multiplicity of parallel reactions, interdependent, interrelated and interwoven, which is as yet so susceptible to simplification that it can be accounted for by a definitive explanation in this way. At the same time one may hope that with further knowledge and with greater study the process will eventually be explained along these lines. This presentation is merely of the nature of a starting hypothesis; in a subsequent lecture I shall determine how far it can be used as a scaffolding to help reconstruct some problems of a more clinical nature.

ARTERIOSCLEROTIC DISEASE OF THE OPTIC NERVE*

BERNARD J. ALPERS, M.D.
AND
I. J. WOLMAN, M.D.
PHILADELPHIA

Arteriosclerosis may cause a disturbance in the function of the optic nerves varying from partial disability to complete optic atrophy. This seems to be a fairly widely accepted clinical view, and yet this factor in disease of the optic nerve receives scant attention. That it is a factor of some clinical importance is indicated by the case that we report, in which visual disturbances are directly traceable to arteriosclerotic factors in the optic nerves and chiasm.

REVIEW OF LITERATURE

The number of contributions to the subject of arteriosclerotic disease of the optic nerve is not great. They may be divided roughly into two groups: (1) cases of partial destruction of the optic nerves, and (2) cases of complete optic atrophy.

One of the first contributions to the subject was that of Michel,[1] who reported bilateral choked disk with good function of the optic nerves for a year, followed by rapid loss of function. Necropsy showed a compression of the optic nerves by dilated and tortuous internal carotid vessels. In 1887, Oppenheim and Siemerling[2] defined the clinical syndrome and found that the optic nerves were not rarely involved in arteriosclerosis, and that the changes were either slight or marked, the latter resulting in total atrophy. They reported three cases, one of which showed total atrophy; the other two showed lesser changes, such as proliferation of the connective tissue, nuclear increase and the formation of new vessels. In seventeen cases of arteriosclerotic disease of the nerve, Otto[3] found six with flattening of the optic nerve due to

* Submitted for publication, Feb. 10, 1931.

* From the Ayer Clinical Laboratory of the Pennsylvania Hospital, and the Laboratory of Neuropathology in the Institute for Mental Hygiene, Pennsylvania Hospital, Philadelphia.

1. Michel: Arch. f. Ophth. **23**:220, 1877.

2. Oppenheim, H., and Siemerling, M., quoted by Liebrecht: Arch. f. Augenh. **25**:193, 1902.

3. Otto: Ueber Veränderungen des N. opticus, insbesondere bei Arteriosklerose, Arch. f. Psychiat. **25**:559, 1893.

dilated internal carotids and eleven with total optic atrophy due to the involvement of the vessels. Liebrecht [4] clarified the subject by demonstrating on the basis of seven cases that injury to the optic nerve in cases of arteriosclerosis is due to involvement of either the internal carotid or the ophthalmic arteries and occurs in one of three places: (1) in the continuation of the bony optic canal into the fibrous portion by a boring in of the ophthalmic artery; (2) at the upper edge of the fibrous canal through pressure of the carotids, and (3) between the canal and the chiasm where the internal carotid and anterior cerebral arteries cross the optic nerves.

The subject was reviewed in the comprehensive work of Wilbrand and Saenger,[5] who collected the cases up to 1913. Despite the prevailing opinion that this is a common lesion, the number of reported cases to this date is small, and in many of them the pathologic condition is due to pressure on the optic nerves or chiasm by an aneurysm. This is not what is meant, strictly speaking, by arteriosclerotic disease of the optic nerve. In many of the cases reported there have been aneurysms of the cerebral vessels with compression of the optic nerves. In relatively few instances has there been compression of the nerve by a thickened vessel without aneurysmal formation. Wilbrand and Saenger reported a case with decrease of vision for six months, with total atrophy of the left eye and atrophy of the temporal half of the disk in the right eye. Necropsy showed a mild flattening of both optic nerves by rigid internal carotids. De Schweinitz [6] said that "undoubtedly it (primary optic atrophy) may be due to arteriosclerosis," and further that "compression around the optic foramen is likely to produce secondary atrophy by direct injury to the fibres of the optic nerve."

Uhthoff [7] expressed the belief that there are cases of optic atrophy which in the absence of other etiologic factors are due to arteriosclerosis. He reported three such cases. In all three the visual disturbances developed rapidly. First there was optic neuritis of only a few weeks' duration, followed by optic atrophy. In one case it was unilateral. In the other two cases it was bilateral, affecting one eye two and a half months and five years, respectively, after the other. Focal cerebral signs were lacking in Uhthoff's cases, the only sign being generalized arteriosclerosis and increased blood pressure. The visual disturbances in these cases were severe and ended with marked defect in the visual field. In

4. Liebrecht: Sehnerv und Arteriosklerose, Arch. f. Augenh. **25**:193, 1902.

5. Wilbrand and Saenger: Die Neurologie des Auges, Munich, J. F. Bergmann, 1913, vol. 5.

6. de Schweinitz, George: Diseases of the Eye, Philadelphia, W. B. Saunders Company, 1924.

7. Uhthoff, W.: Zu den entzündlichen Sehnervaffektionen bei Arteriosklerose, Zentralbl. f. d. ges. Neurol. u. Psychiat. **42**:151, 1925-1926.

two cases only small eccentric parts of the visual fields remained, while in the third case there was a large central scotoma.

Recently, Mazzatesta [8] showed in three cases that compression of the optic nerve in arteriosclerosis always occurs in the fibrous part of the canal. The nerve is pressed against the ophthalmic artery, indentations occur and degeneration follows. Ophthalmoscopic examinations may give negative results for some time.

Von Stief [9] reported a case of a woman, aged 76, who was blind for four years and who showed arteriosclerosis of the vessels in the chiasm and optic nerves and a marked loss of myelin sheaths. He pointed out that the changes in the optic nerves are not parallel with those elsewhere. Thus, one may have severe changes in the internal carotid and ophthalmic arteries and mild changes in the optic nerves and vice versa.

Finally, mention must be made of the remarkable case reported by Henschen [10] with blindness in the right eye and a circumscribed softening in the optic chiasm and optic tract and atrophy of the optic nerves. This is the only case of softening confined to the optic chiasm of which we have record.

REPORT OF CASE

Essential hypertension in a woman of 44, with cardiac enlargement, slight aortic insufficiency and some ocular symptoms. Compression of the optic nerves, especially the left, by sclerosed internal carotid arteries. Focal changes in the optic nerves and chiasm.

History.—A woman, aged 44, who had been under observation since 1925, gave a history of numerous attacks of tonsillitis, and an attack of gonorrhea at the age of 16, for which she was treated by removal of both tubes and ovaries. The heart and lungs were normal at this time, but no observations were made on the blood pressure.

In November, 1925, she was admitted to the Pennsylvania Hospital, where a diagnosis of hypertension was made. She said that a physician had called her attention to this in 1918, and that she had a blood pressure of 165 at this time. In November, 1925, the blood pressure was 200 systolic and 120 diastolic. The left border of the heart was 12.5 cm. to the left of the midline in the fifth interspace, and the right border was 4.5 cm. to the right in the fourth interspace. Analysis of the blood showed; urea, 18 mg.; creatinine, 1.3 mg., and sugar, 96 mg. The urine was normal, and examination of the eyes showed no abnormality at this time.

In December, 1926, the patient was treated in the eye clinic for a complaint of blurring of vision in the right eye. Ophthalmoscopic examination of the right eye showed a few vitreous opacities in the media, a swollen and slightly blurred

8. Mazzatesta: Lesioni endocraniele del nervo optico per arteromosia della caroticle e dell' oftalmica, Riv. oto-neuro-oft. **2**:180, 1925.

9. von Stief, A.: Zur Histopathologic des Sehnerven bei Arteriosklerose und bei der senilen Demenz, Ztschr. f. Augenh. **71**:41, 1929.

10. Henschen, S.: Ueber circumscripte arteriosklerotische Nekrosen in den Sehnerven, im Chiasma, und in den Tractus, Arch. f. Ophth. **78**:212, 1911.

optic disk. The macula showed a star-shaped exudate spreading out from a central area. The vessels were somewhat sclerosed. Save for the same sort of a sclerosis in the left eye, ophthalmoscopic examination of this eye gave negative results. The blood pressure at this time was 208 systolic and 142 diastolic. The urine showed a faint trace of albumin but nothing else.

In May, 1927, the blood pressure was 200 systolic and 125 diastolic.

In May, 1929, the blood pressure was 226 systolic and 124 diastolic. The blood sugar was 96 mg., and the blood urea 17 mg. No ophthalmoscopic examination was made at this time.

Fig. 1.—The optic nerves are compressed by the sclerosed internal carotid arteries. The left optic nerve is much more compressed than the right, but the latter is also affected.

The final admission was in November, 1929. The left border of the heart was 12.5 cm. from the midline in the fifth interspace. The right border was 3.5 cm. from the midline in the fourth interspace. At the pulmonic area along the left border of the sternum was a loud diastolic murmur. Both the second aortic and second pulmonic sounds were accentuated. There was a blowing systolic murmur at the apex. The blood pressure was 220 systolic and 110 diastolic. Examination of the eye by Dr. Shoemaker at this time showed well defined and flat disks with rather small arteries, but with no sign of hypertension. Examination of the urine gave negative results. The Wassermann reaction of the blood was negative, but the Kahn reaction was moderately positive. The blood urea was 19 mg. and the

creatinine, 1.3 mg. The phthalein test was 25 per cent in two hours, but the test was unsatisfactory. The patient was transferred to a convalescent home. She died and willed her body to the hospital.

Necropsy.—The examination of the systemic organs showed generalized arteriosclerosis, cardiac hypertrophy and dilatation, acute mild circulatory congestion of the liver, spleen, kidneys and lungs and chronic arteriosclerotic nephritis.

The brain was a little small and was markedly edematous. At the base of the brain was an intense arteriosclerosis involving the entire circle of Willis and the

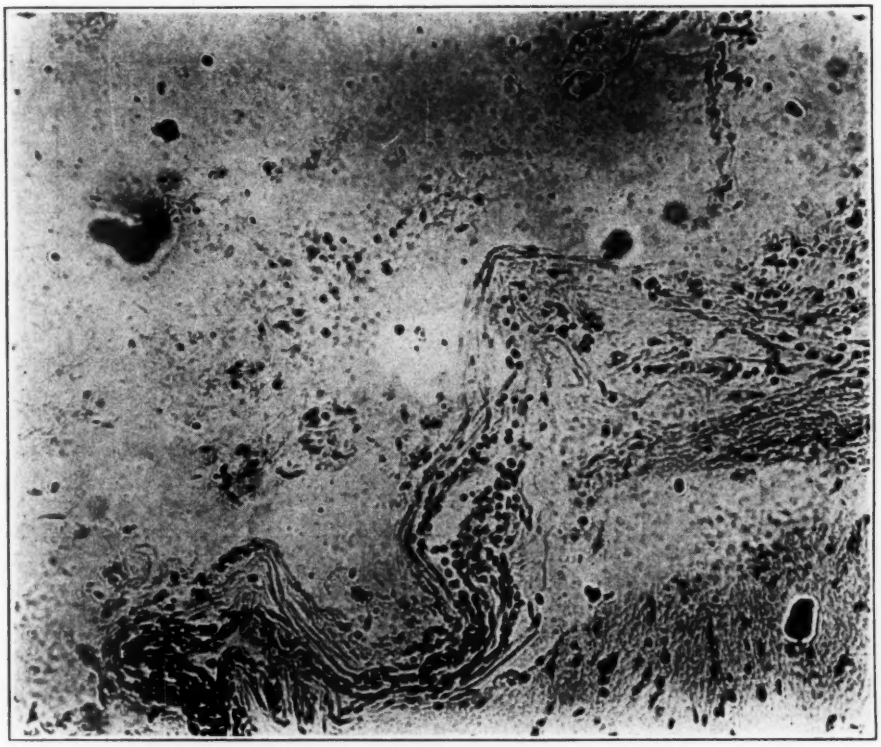

Fig. 2.—Round cell infiltration in the sheath surrounding the optic nerve; toluidine blue stain.

vertebral arteries. The left vertebral artery was much larger than the right, and showed an aneurysmal dilatation. Throughout the course of all the vessels, the walls were markedly calcified. Both optic nerves (fig. 1) showed definite compression by the sclerosed internal carotid arteries. The arteries lay in close approximation to the nerves. The left carotid artery in particular had hollowed out a place in the left optic nerve. The latter was markedly compressed in its external portion. This portion was almost flattened out, while the inner portion was compressed to a lesser degree. The right optic had been markedly compressed so that it was about 2 mm. in thickness in its entire extent. On the whole, the right optic nerve was less compressed than the left which in one portion had been flattened out practically to a ribbon.

Fig. 3.—A focus of round cell infiltration at the junction of the optic tract and the lateral geniculate body; toluidine blue stain.

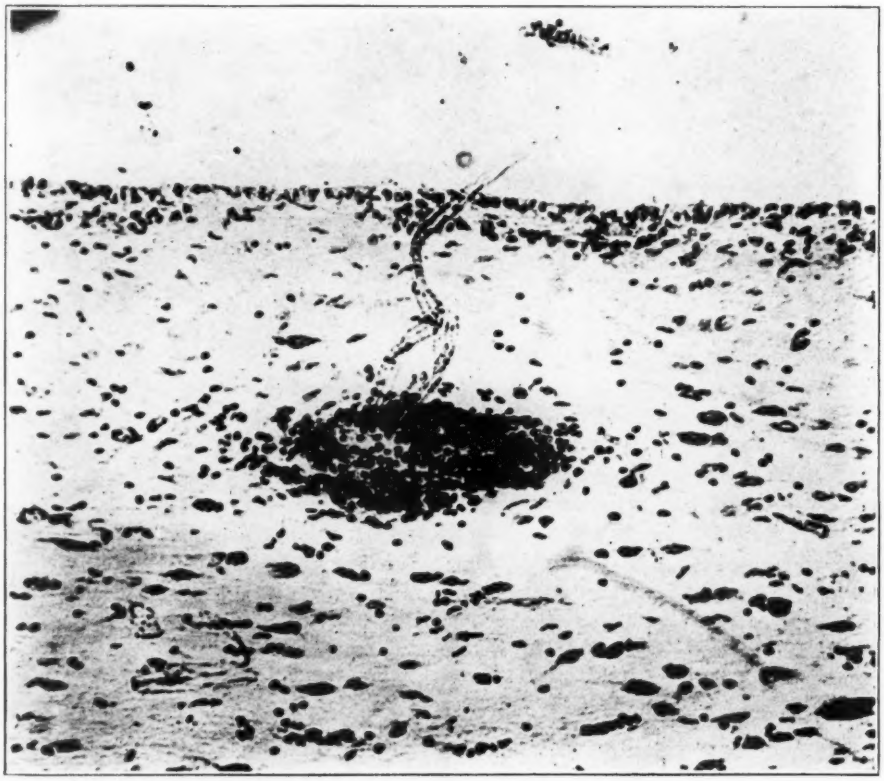

Fig. 4.—The same focus as in figure 3 under higher magnification.

Microscopic Examination.—The cortex showed a loss of ganglion cells in the third lamina. This was diffuse, but was most pronounced in the frontal area. In the meninges the vessels showed hyalinization of the walls of the arteries. In the cortex also there was hyalinization of the arteriole walls, but while this was quite widespread it did not involve all the vessels. The ganglion cells had long, tortuous processes, the Nissl bodies were scant, the nuclei pyknotic and the entire cell shrunken in size. The frontal cortex was involved most of all in the process. The temporal area showed similar changes, but to a lesser degree, while the occipital cortex showed relatively few changes. The large pial vessels showed well pronounced arteriosclerosis.

Fig. 5.—A similar focus showing small round cells and larger oval cells in the collection; toluidine blue stain.

The Nissl stains showed a rather diffuse increase in the astrocytic neuroglia nuclei in the chiasm, and to a lesser degree in both optic nerves. In the latter, there was hyalinization of the arterioles. This was not universally present, but was more than an occasional occurrence. Similar hyalinization was found at the junction of the optic tract and lateral geniculate bodies.

In both geniculate bodies at their junction with the optic tracts, small foci of cells could be seen. These lay just beneath the periphery of the optic tract. They were composed of two types of cell elements: one of these was an oval cell, with oval, vesicular nucleus, and the other was composed of round cells which had a heavy network of chromatin and scanty cytoplasm. These cells looked like lymphocytes. In some foci the lymphocyte-like elements predominated, while in

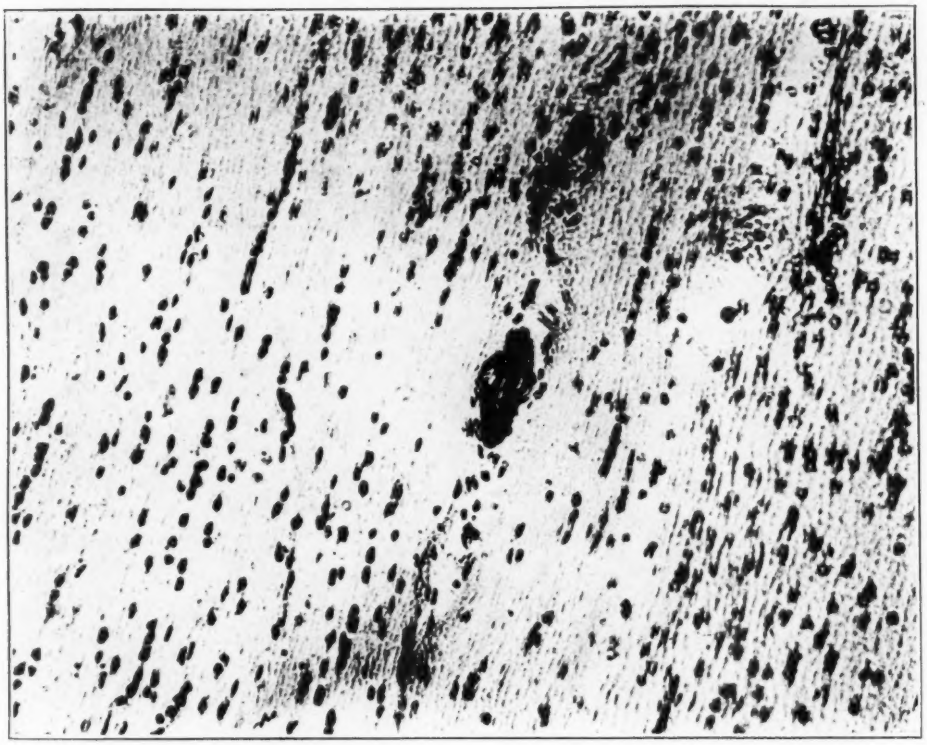

Fig. 6.—A hyalinized vessel in the optic nerve; toluidine blue stain.

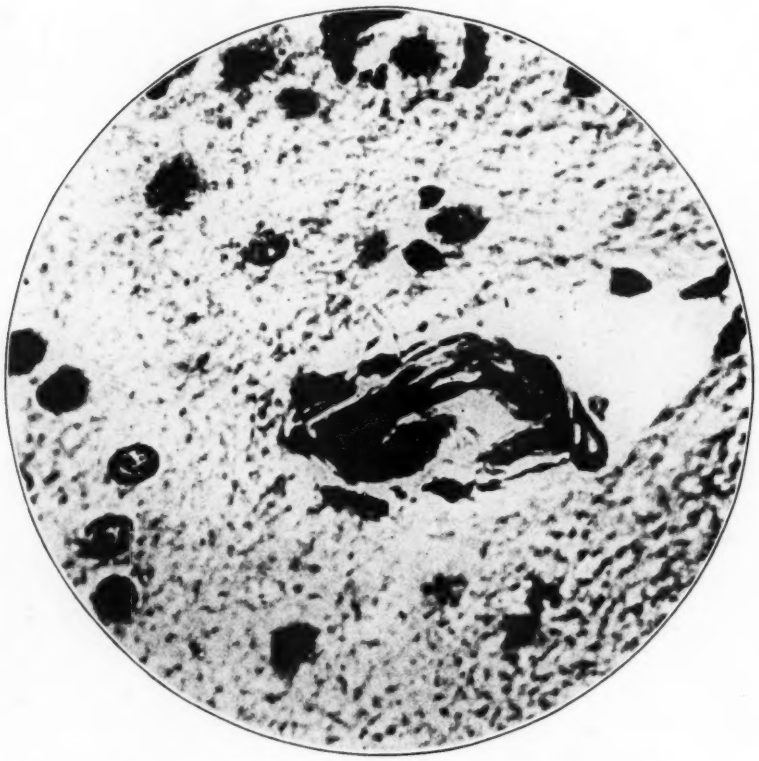

Fig. 7.—The same vessel as in figure 6 under higher magnification.

others the macrophage elements were more prominent. In the sheath around the optic nerves small foci of cells were seen, similar in nature to those previously described. Myelin sheath stains showed possibly a slight decrease in myelin, but this was so mild as to be unimportant. Fat stains were not made.

COMMENT

It is important to recognize that obscure visual disturbances of varying intensity may be caused by an arteriosclerosis which may operate in one of two ways: either by direct compression of the optic nerves by the internal carotid arteries or by arteriosclerosis of the vessels within the nerves and visual tracts themselves. The result may be complete optic atrophy with total loss of vision or partial loss of visual acuity with or without atrophy of the optic nerve and often with a scotoma. The occurrence of visual disturbances due to arteriosclerosis is well recognized, and is one of the clinical facts that seems to have been thoroughly accepted. Nevertheless, its occurrence is by no means as frequent as one would surmise. If the cases of visual disturbances due to aneurysm are excluded, the number of reported cases of compression of the optic nerve due to merely thickened and sclerosed internal carotid arteries are few. Strictly speaking, the compression of the optic nerves by aneurysms in the ophthalmic artery and elsewhere are arteriosclerotic cases, but the case here reported is not such an instance; we have chosen to confine our report, therefore, to cases in which the vessels have compressed the nerves by mere thickening of their walls and cases in which there has been found arteriosclerosis within the optic nerves or tracts in the absence of the direct compression previously mentioned.

We have already stated that the cases of arteriosclerotic disease of the optic nerve that have been reported fall into two groups: (1) a group in which there has been optic atrophy with almost complete or total loss of vision, and (2) a group with only a slight decrease in visual acuity, no optic atrophy and the occasional presence of a scotoma. There is usually evidence of arteriosclerosis eleswhere in the body in both groups of cases. Retinal arteriosclerosis has not usually been present in the cases reported in the literature. It seems possible that at least some of the obscure cases of optic atrophy and of obscure visual disturbances may be due to one of the two types of arteriosclerosis mentioned. Uhthoff [7] expressed the belief that in the absence of other causative factors it is safe to ascribe optic atrophy to arteriosclerosis in instances in which the etiology is obscure. Our patient complained of subjective disturbances of the eye consisting of blurring in the right eye four years before death. Examination of the right eye showed a disk that was swollen, with slight blurring of outline, and a star-shaped exudate in the macula. For some time before her death, the patient

complained of eye strain, and of "dizziness in the eyes." Examination of the eyegrounds by Dr. Shoemaker about four months before her death, however, showed normal optic nerve heads. It is possible that there were more subjective complaints of optic disturbances, but since the patient was not under medical care for some time before her death we cannot be certain of this. In any event, there were visual disturbances that may be traced back to the changes found in the optic nerves and to the compression of the latter by the sclerosed internal carotid arteries. It is extremely interesting that there were evidences of a beginning optic neuritis in the left eye with the onset of visual symptoms. These may have been due to the sudden compression of the left optic nerve by the internal carotid artery. The subsequent disappearance of these symptoms may be traced to an adjustment of the nerve to the compression, and this is further borne out by the fact that despite the compression of the nerve by the internal carotid artery, there is no degeneration of the myelin sheaths or axis cylinders in either optic nerve. The compression, therefore, was sufficient to cause a sudden blurring of vision and optic neuritis without subsequent atrophy, and was just enough to call forth infiltrative changes in both optic nerves, resulting in subjective complaints of blurring and "dizziness of vision."

The pathogenesis of these arteriosclerotic visual disturbances is not always the same. There are some cases in which the optic atrophy may be traced directly to compression of the nerve. These are the cases of so-called pressure atrophy. Oppenheim and Siemerling [2] believed that in some cases the process is a primary arteritis, and that compression of the nerve plays only a secondary rôle. Probably the arteriosclerosis of the small vessels within the optic nerves plays fully as important a rôle in the production of the visual disturbances as does the compression by the sclerosed internal carotid vessels. The result is a lack of nourishment of the tissues with the resulting changes described by Alzheimer: a focal loss of nervous tissue, with perivascular gliosis. Compression atrophy may play the sole rôle in some cases, arteriosclerosis within the optic nerves and tracts in others, and in some cases the two may be combined, as in our case. It is of interest to note, as von Stief [9] pointed out, that there may be severe changes in the vessel within the optic nerve and only mild changes elsewhere in the vessels of the circle of Willis.

The nature of the focal infiltrations that were found in our case has aroused some interest. Some reports consider them inflammatory in origin. They are composed of small lymphocytes, fibroblasts and macrophages, and conform to what Spielmeyer called "symptomatic" inflammation, due in this instance to compression by the sclerosed internal

carotid vessels. The process is not primarily inflammatory, and the presence of inflammatory elements in this case can be ascribed to irritation from other causes.

CONCLUSIONS

1. A case of compression of the optic nerves by sclerosed internal carotid arteries, resulting in transient visual disturbances, is reported.

2. These arteriosclerotic disturbances of the optic nerve are probably not uncommon, and may be the cause of unexplained visual difficulties in cases of arteriosclerosis.

TYPES OF OPHTHALMIA NEONATORUM NOT DUE TO THE GONOCOCCUS*

N. K. LAZAR, M.D.
Ward Fellow in Ophthalmology, Northwestern University Medical School
CHICAGO

While the gonococcus is known to be responsible for most cases of ophthalmia neonatorum, there are a number of cases in which bacterial examinations for the gonococcus yield negative results. These cases have been ascribed to various causes, such as chemical irritants, certain organisms and the so-called inclusion virus. It seemed that a systematic study of a series of such cases with a view to determining this etiology was worth while.

In a review of the literature, Gabrielides [1] reported that Augé, in 1906, in a series of 95 cases of nongonorrheal ophthalmia of the newborn found no organisms in 77, pneumococcus in 10, streptococcus in 3, Koch-Weeks' bacillus in 3, Pfeiffer's bacillus in 1 and an undetermined organism in 1. Haupt,[2] in a series of 62 cases of ophthalmia of the new-born, found 45 due to the gonococcus, 1 to pseudo-influenza, 1 to *Bacillus coli,* 1 to the streptococcus and 2 to *Bacillus influenzae*; in 11 cases no organisms were found. Welker, in a series of 217 cases, found 97 of gonorrheal origin, 39 due to other organisms and 81 in which there were no organisms. Groenouw,[3] in an exhaustive study of 100 cases of ophthalmia of the new-born, found that 41 were of gonorrheal origin, 5 were due to streptococcus, 1 to micrococcus, 4 to staphylococcus, 5 to pneumococcus, 13 to saprophytes and 29 to no organisms. Sherman [4] found that 65 per cent of a series were due to the gonococcus, 10 per cent to pneumococcus, 5 per cent to *B. coli* and 5 per cent to ordinary organisms. Cantonnet,[5] in a series of 42 cases of purulent conjunctivitis of the new-born, found the gonococcus in 18.5 per cent, ordinary organisms in 12.5 per cent and no organisms in 59 per cent. He stated that a few smears showed inclusion bodies.

---

* Submitted for publication, Feb. 10, 1931.
* Read before the Chicago Ophthalmological Society, Feb. 16, 1931.

1. Gabrielides: Des Conjunctives, Constantinople, Estia-Galata, 1921.
2. Haupt: Klin. Monatsbl. f. Augenh. **41**:447, 1903.
3. Groenouw: Arch. f. Ophth. **52**:1, 1901.
4. Sherman: J. M. Soc. New Jersey **7**:172, 1901.
5. Cantonnet: Presse méd. **29**:426 (May 28) 1921.

Other writers [6] called attention to the fact that so-called "argentum catarrh" is common.

A voluminous literature has arisen about the condition in which inclusion bodies but no organisms are found and which has come to be known as "inclusion blennorrhea" of the new-born. More will be said of this condition in an analysis of the results of the present work. The work presented represents a series of eighty cases of ophthalmia of the new-born. The eyes of these patients were not treated with any medicament except possibly one irrigation of physiologic solution of sodium chloride or of boric solution. They represent cases seen from

TABLE 1.—*Cases Showing the Same Organism in Scraping and Culture*

	No. Cases
Pneumococcus	13
Staphylococcus	3
Mixed organisms	3
Morax-Axenfeld bacillus	1
No organism	14

TABLE 2.—*Résumé of Observations in Forty-Four Nongonorrheal Cases*

	Epithelial Scraping	Culture
No organism	20	21
Pneumococcus	13	14
Staphylococcus	6	5
Mixed organisms	4	3
Morax-Axenfeld bacillus	1	1
Inclusion bodies	6	..

thirty-six hours to two weeks after birth. Cultures and scrapings were made within a few hours after the condition was recognized. The bacteriologic technic was as follows:

The platinum loop was dipped into the conjunctival sac and gently scraped along the floor so as to loosen a little epithelium; this was introduced into the culture mediums. Other methods of preparing the culture were considered, but it was felt that in view of the peculiar anatomic structure of the conjunctiva the foregoing method was more efficacious. All cultures were incubated for twenty-four to forty-eight hours. In a few cases the cultures were repeated. Several mediums were tried, but it was found that Besredka's egg medium was capable of growing most of the organisms except the gonococcus; for the latter, the Kinsella-Broun-Garcia [7] medium was found to be excellent, growth appearing in

6. Axenfeld: Bacteriology of the Eye, London, Baillière, Tindall & Cox, 1908, p. 426; Monatschr. f. Geburtsh. u. Gynäk. **1**:287, 1895. Cramer: Arch. f. Gynäk. **59**:52, 1899.

7. Kinsella; Brown, and Garcia: J. Infect. Dis. **32**:1, 1923.

from twenty-four to forty-eight hours. Epithelial scrapings were made in all cases with a sharp platinum spatula, no cotton applicators being used in preparing the slides. Slides were stained by methylene blue (methylthionine chloride, U. S. P.), Gram's and Giema's methods, Lindner's contrast strain being used in several cases. Microscopic examination of the culture was made from a Gram preparation after twenty-four to forty-eight hours'—and in a few cases seventy-two hours'—incubation. In all epithelial scrapings showing gram-negative intracellular diplococci, these were considered as gonococci and in only a few of these cases were cultures made. If no organism or a mixture of organisms was found, cultures were taken and a regular examination was made.

The clinical picture in these cases varied, but on the whole one can summarize the general characteristics of cases by groups (as seen in table 1). The cases showing no organisms on scraping or culture were mild, a discharge appearing from the second to the twelfth day; they ran a mild course and cleared up within a few days on irrigations of physiologic solution of sodium chloride and mercurochrome-220 soluble, 1 per cent, twice daily. There were fourteen cases of this type. Although the cause of these must remain uncertain, the most probable one seems to be the chemical effect of silver.

The thirteen patients who showed gram-positive extracellular diplococci were first seen from two to fifteen days after birth. A number of these cases ran a more protracted course, and resembled in many respects gonorrheal ophthalmia. There was no corneal involvement. Three cases showed staphylococci in both scraping and culture. The organisms found in the three cases of mixed infection included *Bacillus xerosis,* gram-negative bacilli, gram-positive cocci and gram-negative and gram-positive diplococci, the latter being considered as probable involutional forms of the staphylococcus. The clinical course of the two latter groups was uneventful.

One case that might not be called ophthalmia neonatorum is included in this series because of its rarity and peculiar indications: An infant, aged 6 weeks, had a Morax-Axenfeld bacillus infection, the organism being found on scraping and culture. The course in this case was protracted, the condition involving both eyes, with a corneal complication in one eye. Incidentally, Giemsa's method showed a well defined cell inclusion.

Table 2 is a résumé of all the observations. Attention is here called to the six cases in which inclusion bodies were found. In three of these cases no organism was found on scraping or culture. One showed pneumococci and one a mixed infection. The sixth case was that of Morax-Axenfeld bacillus infection which showed typical inclusion bodies.

Table 3 is a detailed study of all the cases observed. It will be noted that less than 50 per cent of the cases were gonorrheal. In these

thirty-six cases there was no corneal involvement and the clinical course was uneventful. All the cases were bilateral with a typical profuse discharge, swollen lids and edematous conjunctiva. The infants were seen between thirty-six hours and six days after birth, and as a rule the gram-negative intracellular diplococcus was observed on the first

TABLE 3.—*Detailed Bacteriologic Observations in Eighty Cases* *

Case	Giemsa's Method	Gram's Method	Culture
1	No organisms	No organisms	No growth
9	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
10	Extracellular diplococci	Gram + extracellular diplococci	No growth
11	No organism	No organism	Gram + and — cocci; bacilli
12	Cocci; bacilli	Gram + and — cocci; bacilli	No growth
13	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
14	Many cocci; bacilli	Gram + and — cocci and bacilli	All cocci
18	No organism	No organism	No organism
19	No organism	No organism	No growth
20	No organism	No organism	No growth
25	No organism	No organism	No organism
26	No organism	No organism	No growth
27	No organism	No organism	No growth
28	No organism	No organism	No growth
29	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
31	No organism	No organism	Gram + diplococci
32	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
33	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
34	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
41	No organism	No organism	No growth
44	Cocci; bacilli; many B. xerosis	Gram + and — cocci; bacilli	Many gram + cocci; gram + diplococci
45	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
46	Extracellular diplococci; many bacilli	Gram + diplococci; gram — cocci; gram — bacilli	Gram + diplococci; gram — cocci
47	No organism	No organism	No growth
55	Many cocci	Gram + and — cocci; extracellular diplococci	Gram + and — cocci
56	Cocci; staphylococci	Gram + cocci	Gram + cocci
57	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
58	Extracellular diplococci	Gram + diplococci	Gram + diplococci
61	No organism	No organism	No growth
62	No organism	No organism	No growth
63	Inclusion bodies	No organism	No growth
65	Inclusion bodies	No organism	No growth
66	Cocci; bacilli	Gram + and — cocci; bacilli	Gram + and — cocci; bacilli
67	Inclusion bodies	No organism	No growth
68	Cocci	Gram + cocci	No growth
70	Inclusion bodies; extracellular diplococci; bacilli	Gram + extracellular cocci; bacilli	Gram + cocci; gram + and — bacilli
72	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
74	Inclusion bodies	Gram + extracellular diplococci	Gram + diplococci
76	Extracellular diplococci	Gram + extracellular diplococci	Gram + diplococci
77	Inclusion bodies; intracellular diplobacillus	Gram — diplobacillus	Gram + diplobacillus

* Thirty-six of these were cases of gonorrheal ophthalmia.

scraping. It is interesting to note that several of these cases showed a thin membrane; when this was rubbed off with a piece of cotton, profuse bleeding occurred.

COMMENT

The statistics presented in this work coincided in a measure with the work of others. The number of cases showing the pneumococcus is larger than that given by others. However, Heyman [8] in a series of

8. Heyman: Berl. klin. Wchnschr. **47**:663, 1910.

cases called attention to the more common occurrence of this organism than has heretofore been supposed. Schmidt-Rimpler, Credé, Axenfeld [6] and others called attention to the presence of the organism in the new-born. In his series of 100 cases, Groenouw found 5 due to this organism. During recent years the percentages have been higher. It is my belief that aside from the variations in the geographic distribution of this organism, the method of obtaining a slide preparation is important. It was especially observed in the present work that an epithelial scraping often showed organisms when a smear as ordinarily prepared with a cotton applicator showed none.

When considering the number of cases showing no organisms either on scraping or culture, one must take into account the results of delivery and the use of a chemical irritant, such as 1 per cent silver nitrate. It will be noted that the percentage of cases giving bacteriologically negative results (35 per cent) is higher than that found in many series of cultures taken from the normal adult conjunctiva, which show organisms in over 90 per cent of properly made cultures. While differences in technic may partially explain this, it is also probable that the flora of the conjunctival sac is not so profuse in the new-born infant as in adults; further, the use of a silver preparation may have inhibited bacterial growth. The remaining cases in this series are those in which inclusion bodies were found, the cases of so-called "inclusion blennorrhea." Gifford and I [9] showed that these cellular inclusions can be produced artificially with a chemical irritant or an organism. Others have shown them to be present in the epithelial cells of most of the mucous membranes of the body. In three cases showing cell inclusions no organism was found on scraping or culture (fig. 1). In three other cases of the series which showed inclusion bodies or cell inclusions, an organism was demonstrated on both scraping and culture. Case 77 showed an intracellular gram-negative diplobacillus in an infant, 6 weeks of age, who had had a slight discharge since birth. Cultures were made about three weeks after birth and cell inclusions were found along with the bacilli. It is interesting to note that in the cornea of one eye ulceration and opacification developed. The infection was bilateral. Axenfeld reported that Andrade and Collomb and others found this organism in the new-born infant. Case 74 (fig. 2) showed gram-positive extracellular diplococci on scraping and culture. This is shown not as a typical inclusion but as one of a series in which there were cell inclusions that apparently represented degenerated organisms. Case 70 (fig. 3), in which there was a mixed infection, showed a more organized cell inclusion. It was distinctly granular, and under the oil immersion lens definite and distinct cocci could be

9. Gifford, S. R., and Lazar, N. K.: Inclusion Bodies in Artificially Induced Conjunctivitis, Arch. Ophth. **4**:468 (Oct.) 1930.

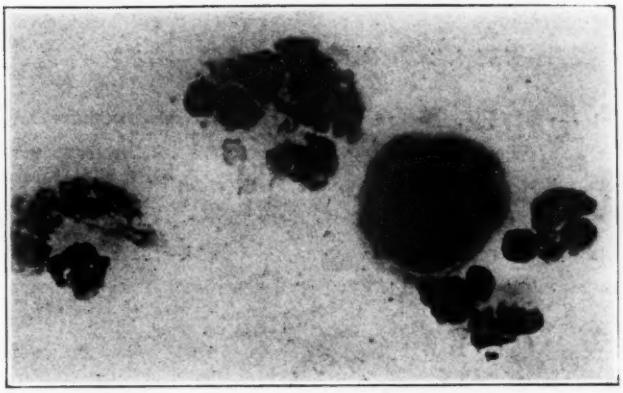

Fig. 1.—A cell inclusion from case 63. No organism was found on culture or scraping.

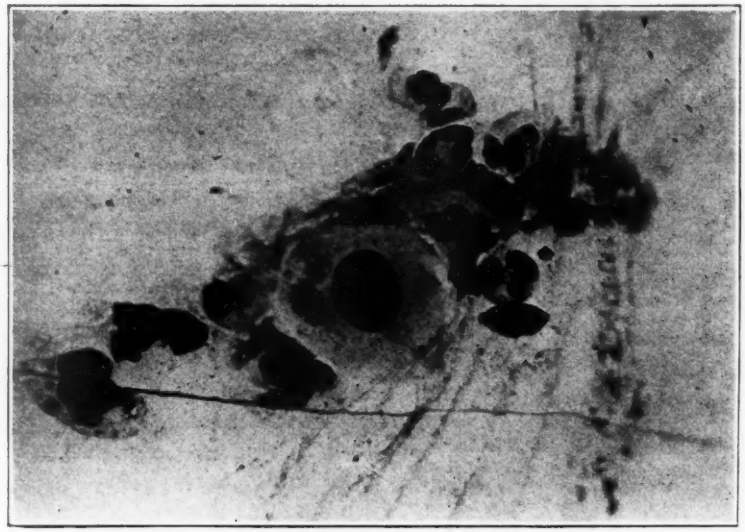

Fig. 2.—A cell inclusion from case 74. The gram-positive extracellular diplococci was found on scraping and culture.

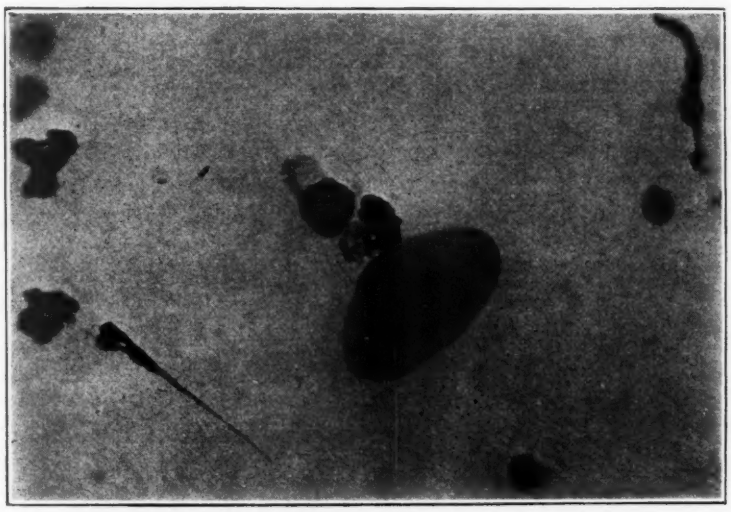

Fig. 3.—A cell inclusion from case 70. Mixed organisms were found.

made out in its center. In a Giemsa preparation many of these cell inclusions could be observed which appeared to be degenerated organisms; this is in accordance with what Bengston [10] found in her work.

In a recent report on five cases of so-called inclusion blennorrhea, James [11] treated it as a distinct disease entity. It is not clear to what extent the bacteriologic work was done, but in the light of present knowledge as to the pathogenesis of these bodies and of the observations in the five cases presented here, it does not appear justifiable to treat inclusion blennorrhea as a distinct disease entity, and to take the inclusion body per se as pathognomonic of a disease of the conjunctiva. Although the three cases presented which showed inclusion bodies and in which no organism was found on scraping and culture do not give support to the theory, the possibility exists that a certain type or types of undetermined organism, possibly of the nature of an ultramicroscopic virus, may cause conjunctivitis in which a large number of such inclusions are formed as a product of the inflammation. The larger number of cases found in Europe as compared with this country raises the question as to whether or not the geographic location may have something to do with this.

In the cases grouped as mixed infection, no attempt was made to isolate or to separate the predominating organism. These and the cases found to be due to staphylococci were of an avirulent form, as shown by the clinical course.

CONCLUSIONS

1. In a series of eighty cases of ophthalmia of the new-born, thirty-six were of gonorrheal origin. Fourteen cases showed no organism on scraping and culture, thirteen showed pneumococcus, three staphylococcus, three mixed organism and one Morax-Axenfeld bacillus. The remainder showed an organism on scraping and not on culture or vice versa.

2. Inclusion bodies were demonstrated in cases showing organisms as well as in those revealing no organisms.

3. It is believed that a distinct type of ophthalmia neonatorum due to organisms other than gonococci can be demonstrated on proper bacteriologic investigation. For such an investigation epithelial scrapings must be used rather than the smear that is ordinarily made.

Miss Mazanec helped in the preparation of the cultures and slides. All of the cases with the exception of about ten were from the Eye Service of the Cook County Hospital.

10. Bengston: Pub. Health Rep. **43**:2210, 1929.
11. James: Am. J. Ophth. **13**:1084 (Dec.) 1930.

ADULT HEREDITARY ANTERIOR MEGALOPHTHALMUS SINE GLAUCOMA: A DEFINITE DISEASE ENTITY

WITH SPECIAL REFERENCE TO THE EXTRACTION OF CATARACT *

DERRICK T. VAIL, JR., M.D.
CINCINNATI

DEFINITION AND SYNONYMS

The term "anterior megalophthalmus" is used to indicate an enlargement of the anterior segment of the eyeball. The most obvious and striking feature is the enlarged circumference of the cornea, and for this reason the disease has been given various names, such as megalocornea, macrocornea, keratoglobus, keratomegalia, cornea globosa, cornea bulbosa, macrophthalmus, hydrophthalmos congenitus anterior, hydrops cameri anterior, globular pellucid staphyloma, gigantophthalmus and enlarged eyeball. It is my purpose in this paper, however, to show that the pathologic changes that characterize this disease are not limited to the cornea but involve the anterior chamber, iris, lens and zonular fibers. As will be shown, the changes are uniform and constitute a definite disease entity which can be easily differentiated from buphthalmos or hydrophthalmos.

HISTORY

Von Muralt, in 1869, separated cornea globosa semper pellucida from congenital hydrophthalmos. Horner and Michel, in 1889, differentiated a disease which they termed "keratoglobus pellucidus" from "keratoglobus turbidus" or hydrophthalmos (buphthalmos) and said:

> Genuine cornea globosa, whose sharply defined margin and absolute transparence was determined through many observations, can exist throughout entire life as solely an enlargement of the circumference of the cornea, bilateral as well as in one eye, frequently in many members of the same family and becomes significant for ocular efficiency only through changes of refraction and in later life a manifested disposition toward cataract and that slightly tremulous.

So far as can be determined, this is the first mention of the entity of this disease, and, as will be seen, a shrewd observation and summary which, with the exception of a few minor points, holds good today.

---

* Submitted for publication, March 20, 1931.

* Read before the Section on Ophthalmology at the Eighty-Second Annual Session of the American Medical Association, Philadelphia, June 10, 1931.

Terson, in 1888, described a case of megalocornea in which he successfully removed the cataract—the first observation of the extraction of cataract in these cases. Following Terson, Pflüger (1894), Warlomont (1894), Epinatjew (1896), Bondi (1898) and Harlan (1898) of Philadelphia described characteristic cases. The older authors of textbooks, notably Axenfeld, Elschnig, Fuchs, Parsons and de Schweinitz, gave scanty attention to megalocornea and considered it an arrested form of congenital buphthalmos or hydrophthalmos sanatus, grouping keratoglobus, buphthalmos and glaucoma congenitum as synonyms. Fuchs stated:

> Some authors (Horner, Haab) distinguish between the form above described (infantile glaucoma with early development of fissures in Descemet's membrane) and genuine Megalophthalmus (Megalocornea) which is a simple overgrowth of the eye, and is unattended by increase of tension or by the characteristic fissures. It is impossible, however, to draw any sharp dividing line between the two forms.

In recent years, however, there has arisen an impressive literature on the subject, especially in the foreign journals, and all authors concerned are of the opinion that genuine megalophthalmus or megalocornea exists as a disease plainly differentiated from buphthalmos. Except for Ball's textbook and articles in the "American Encyclopedia of Ophthalmology," there is little discussion in English of these diseases as separate entities. It is therefore considered necessary to review in full the features that distinguish this disease before presenting certain cases in which the cataracts have been removed.

CHARACTERISTICS

The horizontal diameter of the normal cornea lies between 11 and 12.5 mm. with the average at 11.6 (Peter, Priestley Smith). Macrocornea is to be considered when the horizontal diameter measures about 12.5 or 13 mm. In all cases of genuine anterior megalophthalmus the corneal diameters are enlarged, and may even reach a size of 18 mm. (Seefelder), but all cases of macrocornea are not necessarily to be included in the disease under discussion, since in addition to the enlarged size of the cornea, there are other essential signs. These can be divided into major and minor signs. The major signs are: (*a*) enlarged transparent corneas; (*b*) hereditary or familial incidence; (*c*) always bilateral and almost exclusively limited to the male sex; (*d*) absence of all evidence of glaucoma. The minor signs are: (*a*) deep anterior chambers; (*b*) iridodonesis; (*c*) atrophy of the stroma of the iris and miosis due to atrophy of the dilator muscle; (*d*) embryotoxon or gerontoxon; (*e*) dislocated or tremulous lens, frequently cataractous; (*f*) melanosis corneae or Krukenberg's spindle (Kestenbaum, Staehli); (*g*) presence of visible nerve fibers in the corneal stroma; (*h*) remains of pupillary membrane; (*i*) sharply defined sclerocorneal margin.

Kestenbaum has graphically differentiated this disease from hydrophthalmos (buphthalmos) as follows:

Megalocornea	Hydropthalmos
(1) Almost entirely restricted to males	(1) Relation of male to female, 5:3
(2) Almost always bilateral [1]	(2) 35 per cent unilateral
(3) Almost equal enlargement in both eyes	(3) Unequal enlargement
(4) Normal convexity of cornea (42-45.2 diopters, Kayser) (40-45.5 diopters, Staehli)	(4) Important decrease in the corneal convexity; 37 diopters not rare
(5) Very frequent occurrence of embryotoxon	(5) Embryotoxon not observed
(6) In majority of cases familial occurrence	(6) Rare familial occurrence
(7) No ill effects during puberty (Reis)	(7) Usually ill effects in puberty

Seefelder, in 1914, gave ten reasons for rejecting the theory that the enlargement was due to pressure. These are: (1) absence of corneal opacities or tears in Descemet's membrane; (2) absence of widening of the limbus in spite of enlargement of the anterior part of the eye; (3) sharp definition of the corneal scleral margin; (4) normal appearance of the sclera in the region of the anterior chamber; (5) absence of excavation of the optic nerve; (6) absence of functional disturbance, apart from the optical error; (7) presence of a relatively high astigmatism, not against the rule as in hydrophthalmos; (8) radius of curvature of the cornea shorter than normal; (9) normal tension as recorded by the tonometer; (10) absolute correspondence in the proportions of the two eyes, whereas in bilateral hydrophthalmos there are usually well marked differences.

There are a sufficient number of reports of cases in the literature that show these major and minor signs to say definitely that here is a disease entity, separate and distinct from any other disease, which deserves a place of its own in modern textbooks.

REVIEW OF THE LITERATURE RESPECTING THE FREQUENCY OF THE VARIOUS SIGNS

Reports of seventy-three cases, which are all bilateral and none of which show the slightest evidence of glaucoma, were studied. They are summarized in the following tabulation:

(1) Horizontal diameter of the cornea: lowest, 12.5 mm.; highest, 18 mm. (Seefelder, Pflüger, Gertz); average, 14.8 mm. (132 eyes, fig. 1); normal, 11.6 mm.

1. Kestenbaum reviewed the cases up to 1919 and included several unilateral cases in his statistics (Himly, Coppez, Hird, Axenfeld, Elschnig). The author, however, cannot agree to this since either details are lacking or else Descemet's membrane showed ruptures, the cornea revealed opacities or the sclerotic was bluish discolored.

(2) Sex: males, 67; females, 6.

(3) Age: youngest, 3; oldest, 85; 43 patients over 20 years old.

(4) Radius of anterior curvature of the cornea: lowest, 7 mm.; highest, 8.5 mm.; average (31 observations), 7.5 mm.; normal, average 7.5 mm. (E. Tron).

(5) 39 cases gave a family history of this disease.

(6) Refractive error.

	No. of eyes	
Emmetropia	17	
Hypermetropia	15	
Hyperopic astigmatism with the rule	5	
Hyperopic astigmatism against the rule	3	29
Compound hyperopic astigmatism	6	
Myopia	15	
Myopic astigmatism with the rule	19	
Myopic astigmatism against the rule	4	44
Compound myopic astigmatism	6	
Mixed astigmatism	2	
Total	92	

(7) Analysis of the minor signs according to age (see table 1).

TABLE 1.—*Analysis of Minor Signs According to Age*

Minor Signs (69 Cases)	1-5 Yr.	6-10 Yr.	11-15 Yr.	16-20 Yr.	21-30 Yr.	31-50 Yr.	51-85 Yr.	No age Given	Total
1. Arcus senilis (embryotoxon, gerontoxon)	..	..	1	1	3	12	5	2	24
2. Melanosis corneae (Krukenberg's spindle)	..	..	..	1	..	3	..	..	4
3. Persistent pupillary membrane	..	..	..	2	2	2	2	..	8
4. Iridodonesis and tremulous lens	1	2	3	6	6	14	6	4	42
5. Nerve fibers in cornea	..	..	..	..	1	2	2	..	5
6. Opacities of the lens	..	1	..	1	1	13	8	3	27
7. Deep anterior chambers	1	2	1	1	2	12	7	1	27
8. Irregular pupils	..	..	4	2	..	5	4	1	16

FAMILIAL OR HEREDITARY ASPECTS

Enough evidence has been presented by Kayser, Grönholm, Franceschetti and others to indicate that the condition is hereditary; Kayser of Stuttgart gives a family tree (fig. 2) comprising six generations, in which seventeen persons showed megalocornea. These patients were otherwise healthy and without defects. The heredity is indirect, recessive, sex-linked, transmitted by the females to males, and similar to color blindness, familial optic atrophy, hemophilia and peroneal atrophy (Gower's or Herringham's disease).

Gredig has presented a family tree in which megalocornea was found to be a dominant characteristic. Sufficient data, however, are so far lacking to support this contention.

The cases of true megalocornea in females reported (Kayser, Grönholm) occurred when there was consanguinity in the parents (figs. 2 and 3).

THEORIES REGARDING ETIOLOGY

Arrested Buphthalmos or Hydrophthalmos Sanatus.—The older authors, Axenfeld, Elschnig, Fuchs, Harlan, Warlomont, Soriano and others, most recently Morax, contended that anterior megalophthalmus

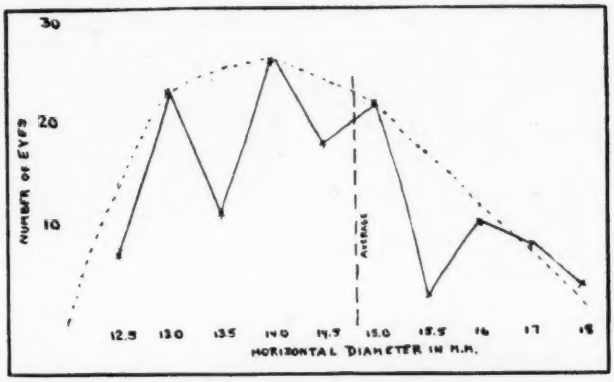

Fig. 1.—Chart showing the average horizontal diameter of 132 eyes with megalocornea.

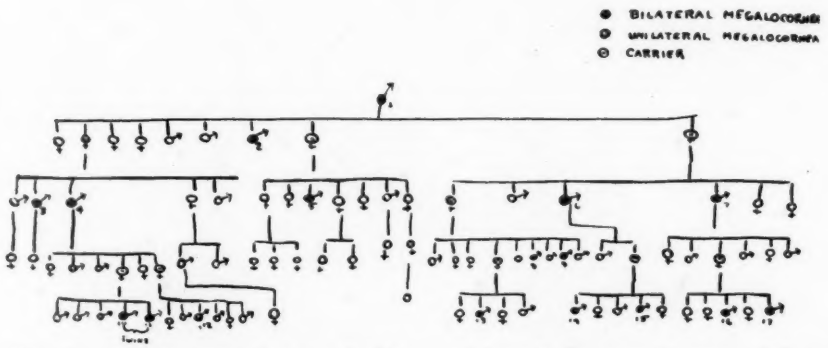

Fig. 2.—Family tree showing incidence of hereditary megalocornea (after B. Kayser).

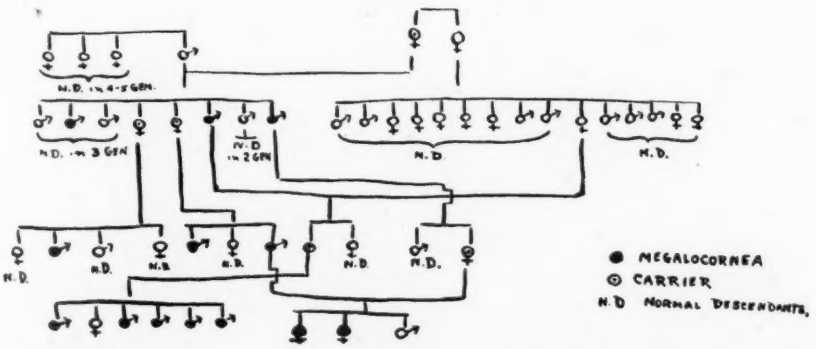

Fig. 3.—Family tree showing incidence of hereditary megalocornea (after Grönholm).

was nothing but congenital glaucoma that had become arrested so that all signs of glaucoma had disappeared, and the eye retained useful vision and functioned normally.

Manifestation of Gigantism or Overgrowth of Entire Eyeball (Seefelder).—Seefelder contended that the large eye was not truly hydrophthalmic but simply a manifestation of gigantism probably of endocrine origin, without the factor of stretching entering into the developmental anomaly.

Without entering into the controversy regarding this theory, it seems logical to believe that in view of the normal radius of curvature of the cornea (Kayser), the normal sized lenses that have been removed in their capsules (Reis, Haab, Salmon, Vail) and the apparent average sized eyeballs, the pathologic process is limited to the anterior segment. Wright found that an eyeball in his case in life measured 27 by 27 mm., and also thought that the nucleus of the lens extracted at operation was larger than normal; but so far as could be determined, this is the only real evidence that has been presented to indicate an enlarged eyeball.

Kayser showed that a gigantophthalmus could exist only when the flattened corneal curve had a radius of about 10 mm., which would not be physiologic. He also claimed that in such a case the lens must be proportionately large. The normal lens is 8.67 mm. in diameter and 4.3 mm. thick. (The lens that Reis removed measured from 8 to 10 mm. by 4 mm.) A megalocornea of 15 mm. would have a lens 11.2 by 5.5 mm., and a megalocornea of 18 mm. would have a lens 13.4 by 6.6 mm. He further claimed that if one can recognize a small globe from 21 to 22 mm. in diameter, one could also recognize a large one of 26 mm.

The controversy can be settled, however, only by a pathologic examination, which has not yet been made.

Heredity Plus Disease or Pathologic Changes (Staehli).—Staehli considered megalophthalmus as a hereditary hyperplasia of the cornea followed by a disease process producing further changes (early spontaneous luxation of cataractous lens, deposits of pigment on the posterior surface of the cornea and atrophy of the iris). Petres also supported this view.

Manifestation of Atavism (Reis, Friede).—Reis and Friede argued independently that since the anterior segment of the eyes of lower animals and new-born infants is larger, megalocornea is an atavistic phenomenon. Friede expressed the belief that the growth of this type of cornea is intra-uterine, and that the insertion of the recti has an influence on the anterior segment.

A rare congenital anomaly called arachnodactylia (or spider-fingers) has been described in the literature. It is characterized by partial

diaphyseal gigantism, remarkable thinness and length of the fingers and toes, masklike facial appearance, winged scapulae, coarse, straight hair and ocular signs.

In ten of the recorded eighteen cases, megalocornea was described together with iridodonesis, congenital dislocated lenses usually cataractous, irregularly deep anterior chambers and contracted pupils that dilate slightly or not at all when atropine is used.

Ormond and Williams considered this disease as atavistic. Igersheimer expressed the belief that endocrine disturbance plays no part in its evolution, but that the abnormal growth of the cornea together with that of the extremities begins from birth.

It is difficult to determine, however, what light the relationship between arachnodactylia and megalocornea throws on the question. Arachnodactylia without megalocornea exists, and vice versa. But it may well be that calcium deficiency, as well as hereditary influences, decides the overgrowth of the affected parts. This theory is supported by the x-ray pictures of the long bones in these cases of arachnodactylia, which show "a slight general rarefaction of the bones of the foot and increase in length of the long bones of hand and foot, slight general rarefaction and some irregularity of structure of the lower end of femur, but no epiphyseal changes" (Ormond and Williams). One of the theories as to the cause of myopia is the lessened resistance of the sclera to normal intra-ocular tension as a result of calcium deficiency in infancy and childhood.

REPORT OF CASES

CASE 1.—*Megalophthalmus; extraction of cataract in the left eye; good result for six years.*

History.—A. D., aged 77, a grocer, was first seen on Jan. 4, 1924, by Dr. Vail, Sr. (fig. 4); the patient complained of painless failure of vision after the age of 65, when he was told that he had cataracts. Vision previously was excellent. He was practically blind in the left eye for twelve or thirteen years before coming to Dr. Vail, but could see to read with the right eye up to six months before. His general health was excellent, and a recent physical examination revealed nothing of importance.

Examination.—Right Eye: The cornea measured 14.5 mm. in its horizontal diameter. There was complete arcus senilis. The pupil was displaced upward and inward, and was 3 mm. in diameter. The pupil responded well to light. The anterior chamber was very deep. A superficial layer of the iris was undergoing "exfoliation" and showed iridodonesis. An immature nuclear and cortical cataract (poor red reflex) was seen. The details of the fundus could not be made out. The tension was normal to palpation, 14 mm. (with the Souter tonometer, normal is from 12 to 16 mm.). The field of vision was normal. Refraction with —4.0 diopters sphere $\frown$ +7.0 cylinder axis 110 showed vision of 20/100; with the addition of +4.0 diopters, the patient could read Jaeger's test type no. 8.

Left Eye: The cornea measured 14.5 mm. The appearance of the eye was the same as that of the right, except that the lens was completely cataractous. The iridodonesis was more pronounced. There was less exfoliation of the iris. The

pupil responded to light. The tension was normal to palpation, 14 mm. (Souter). The patient could count fingers at 6 inches.

Operation.—On February 28, the cataract in the left eye was extracted by Dr. Vail, Sr. An incision was made with the Graefe knife, and a large quantity of aqueous fluid escaped. The lens was delivered on the spoon with Smith's pressure. The lens was about normal in size. A small amount of watery vitreous was lost. The immediate results were good, and healing was normal. Vision with +10.50 diopters sphere ⌒ +1.0 cylinder axis 90 was 20/30+. With the addition of +4.0 diopters, the patient could read Jaeger's test type no. 1. Tension of each eye was normal. The vitreous showed a few stringlike and hairlike floating opacities. The nerve fibers above the disk were opaque, but otherwise the disk was normal. There was no cupping or atrophy.

The patient was last seen on Jan. 12, 1927, when examination revealed the following: There was no red reflex in the right eye. The patient could count fingers at 6 feet. Vision in the left eye, with the glasses prescribed in 1924, was 20/25+, and the patient could read Jaeger's test type no. 1. The surgical result was excellent; the iris pillars were free; there were a clean, black, low pupil, a deep anterior chamber and a normal optic nerve.

Fig. 4 (case 1).—Megalophthalmus.

In October, 1930, a letter from the patient's daughter said that her father died a month before, and that his vision had remained as good as ever to the end.

CASE 2.—*Megalophthalmus; extraction of cataract in the right eye; result, failure at end of the year due to detached retina.*

History.—J. N., aged 35, a carpenter, was first seen on June 1, 1925, by Dr. Vail, Sr. Up to age of 25, the patient could see as well as any one. Then vision in the right eye began to blur. He could read newspaper print with his left eye until nine months before examination. His general health was always good.

Examination.—Right Eye: This eye diverged laterally 10 degrees and upward 5 degrees. The cornea was very large (not measured), and the anterior chamber was deep. The pupil measured 3 mm. in diameter and responded to light. There was iridodonesis. The iris was translucent and showed atrophy of the superficial stroma and absence of crypts. A complete tremulous "soapy" cataract was seen. The tension was 12 mm. (Souter), and the eye was normal to palpation. There was projection of light only in all parts of the field.

Left Eye: The left eye presented the same features as the right, except that the cataract was not so advanced. The patient could count fingers at 2 feet. The tension was 12 mm. (Souter).

Fig. 5.—Megalophthalmus; target reflex on transillumination (semidiagrammatic).

Operation.—On June 3, the cataract in the right eye was extracted by Dr. Vail, Sr. An incision was made upward with a Graefe knife. A large amount of aqueous escaped. Iridectomy was performed and the anterior capsule stripped with forceps, and the milky contents were delivered; there was no nucleus. The pupil was black. It was thought that no vitreous escaped, but in view of the updrawn, boat-shaped pupil that developed later, there must have been some loss of watery vitreous along with the aqueous.

On July 15, vision with +14.50 diopters sphere ⊃ +1.0 cylinder axis 90 was 20/40; with the addition of +3.50 diopters sphere, the patient could read Jaeger's type no. 3.

The pupil was updrawn and boat-shaped but clear. The vitreous showed many large floating opacities in the anterior portion. The optic nerve head, the field of vision and the tension were normal.

On April 5, 1926, there was a complete funnel-shaped retinal detachment in the eye on which operation had been performed. A large tear was seen in the retina below and outward in the posterior part. The patient could count fingers at 5 feet with the foregoing correction.

CASE 3.—*Megalophthalmus; extraction of cataract in the left eye; retinal detachment; failure.*

History.—Mrs. B. M., aged 37, a housewife, sister of the patient in case 2, was first seen by Dr. Vail, Sr., on Feb. 13, 1923. Up to the age of 24 she had good eyesight and could read the finest print without glasses. She married at the age of 18, and had six children, all of whom had normal eyes. Her oldest brother (case 2) and her uncle had cataract. At the age of 24, vision in the right eye blurred. An operation was performed (the patient does not know what was done), but since then she had been able only to see light with the right eye. Vision in the left eye began to fail about two years before examination. Pain or inflammation was not noted. The patient's general health was always considered good.

Examination.—Right Eye: The cornea was flat above; a cystoid scar and operative coloboma of the iris were seen above. The pupil was updrawn, and the iris was in contact with the posterior surface of the cornea. No red reflex was seen, and it could not be determined whether a lens was present or not. The tension was elevated, 34 mm. (Souter). Projection of light was faulty.

Left Eye: The cornea was clear and measured 13 mm. in its horizontal diameter. The anterior chamber was very deep. There was iridodonesis. The pupil measured 3 mm. and was active to light. There was correctopia upward. The iris was grayish green but did not contain crypts. The superficial layer of the iris was atrophied as far as the margin of the pupil. The radiating fibers were wavy. The lesser circle could be faintly made out. The radical ridges were absent. Transillumination showed a ring of shine 0.5 mm. wide just outside the root of the iris in the sclera, the ring being a little more narrow on the nasal side (fig. 5). One could see radial markings in this ring which seemed to be suspensory fibers. The lens was completely cataractous ("soapy") and fluttered. It appeared small. There was projection of light in all parts of the field, normal in the periphery but doubtful in the center. The tension was 14 mm. (Souter).

Operation.—On April 27, the cataract in the left eye was extracted by Dr. Vail, Sr. An upward incision was made with the Graefe knife, and a large amount of aqueous and possibly watery vitreous escaped. The lens was delivered on the spoon with Smith's pressure. The lens was smaller than usual. The eye

was dressed on April 30, and showed the "chamber reestablished, a low black pupil, clear cornea and a dull red reflex probably due to detached choroid, retina or hemorrhage."

On May 29, with a +14.0 diopters sphere, the patient could count fingers at a distance of 10 feet. The retinal detachment was down and out near the posterior pole of the eye. The tension was 12 mm. (Souter).

On August 25, the pupil was drawn up, the cornea flat and the tension low. There was a secondary membrane in the pupillary space, and a faint red reflex. The details of the fundus were not seen. The eye was free from congestion. The patient could count fingers at 6 feet with the foregoing correction.

CASE 4.—*Megalophthalmus; glaucoma in each eye of one year's duration; bilateral trephine operation; later extraction of cataract; good vision for six months, then retinal detachment.*

History.—Mrs. H. J., aged 37, a housewife, was first examined by Dr. Vail, Sr., on Dec. 20, 1923 (fig. 6); she complained of progressive failure of vision in each eye for the past year. For six months before examination, the eyeballs had been aching. Dr. Thigpen of Montgomery, Ala., made a diagnosis of glaucoma.

Fig. 6 (case 4).—Megalophthalmus. Note the small eccentric pupils.

Examination.—Right Eye: The cornea was large, measuring 14 mm. in its horizontal diameter. The anterior chamber was very deep. There were iridodonesis and superficial atrophy of the iris. The pupil measured 1.5 mm. in diameter and reacted fairly well to light. The optic disk was fairly well seen and was normal. The field of vision was normal. The tension was 37 mm. (Souter). Refraction with +2.0 diopters sphere ⌒ +1.0 cylinder axis 10 enabled the patient to count fingers at 5 feet. She could not read at close range.

Left Eye: The cornea was clear, and measured 14 mm. The eye presented the same features as the right. Refraction with +5.50 diopters sphere ⌒ +1.50 cylinder axis 180 showed vision of 20/30+. With the addition of +1.50 diopters sphere, the patient could read Jaeger's test type no. 2 at 8 inches. The tension was 35 mm. (Souter), but the field of vision was normal.

Operation and Course.—On December 22, the Elliot trephine operation was done on the right eye with good surgical results.

On Jan. 8, 1924, the tension in the right eye was 16 mm.; in the left, 38 mm. (Souter).

On January 9, the Elliot trephine operation was done on the left eye, with good surgical results. On discharge the tension was 16 mm. in each eye. Vision

in the right eye with correction was 20/100; in the left, 20/30. With this correction, the patient could read Jaeger's test type no. 2.

On Oct. 10, 1927, the patient complained of rapid failure of vision in each eye. The right eye was practically blind; it just could see light. There was no pain in the eyes.

Biomicroscopy revealed a clear cornea. Nerve fibers were visible as far as the pupillary area. The posterior layer of the cornea showed fine deposits of pigment. The iris was atrophied, the crypts missing. The margin of the pupil was markedly atrophied, and the superficial tissue over the margin was semitransparent. There were posterior subcapsular fluorescent opacities. The left lens showed posterior subcapsular opacities also. Vision in the left eye with correction was 20/50+. The patient could read Jaeger's test type no. 2. The zonular fibers were plainly visible and were stippled with fine particles of pigment. Retinal pigment on the posterior surface of the iris showed through the thinned iris.

On October 11, the cataract in the right eye was extracted by Dr. Vail, Sr. A small incision was made above with the Graefe knife and enlarged with curved scissors. A corneal stitch was applied, and the lens delivered on the spoon with Smith's pressure. The lens was about normal in size. There was slight loss of thin vitreous. The immediate results were good, and healing was excellent.

On November 23, vision in the right eye with +12.25 diopters sphere ⊃ +4.0 cylinder axis 5 was 20/40. With the addition of +4.50 diopters sphere, the patient could read Jaeger's test type no. 2 readily. The tension was normal in each eye. The wound healed without ocular congestion. The optic disk appeared to be normal; there was no cupping or atrophy.

On May 31, 1928, a letter from the patient stated that the retina in the eye on which operation was performed had become detached, and vision was consequently very poor.

CASE 5.—*Megalophthalmus; bilateral retinal detachment and complicated cataracts; operation for retinal detachment and extraction of cataract in one eye, with total loss of the eye.*

History.—Father E. A., a Jesuit priest, aged 52, was seen by me on Sept. 18, 1928. Eight years before, he lost the sight of the left eye from retinal detachment. He said that the ophthalmologist could not dilate the pupils. An ophthalmologist in St. Louis did two scleral punctures at that time. In August, 1928, vision in the right eye became so dim the patient could not read.

Examination.—Right Eye: The cornea was large, 13.5 mm., and the anterior chamber was deep. The pupil was small, reacted sluggishly and did not dilate with 1 per cent atropine. The iris was grayish green and showed iridodonesis. There was atrophy of the stroma at the periphery and margin of the pupil. Nuclear opacities of the lens were present. There were many large flocculent vitreous opacities. The lower portion of the retina was plainly seen; there was baglike detachment of the retina from the roof. A small second detachment was seen on the temporal side, the appearance suggesting two large grapes suspended from above. The tension was 10 mm. (Souter). There was a large defect of the field of vision down and medially.

Left Eye: The cornea measured 13 mm. The anterior chamber was deep, and the pupil was small and responded sluggishly to light. There were a mature cataract, iridodonesis, and atrophy of the stroma of the iris as in the right eye. The tension was 10 mm. (Souter).

The patient returned to St. Louis and had several operations performed on the right eye. I saw him again on Dec. 12, 1930, at which time he showed

phthisis bulbi of the right eye. The left eye appeared the same as before. The patient was totally blind.

CASE 6.—*Megalophthalmus; extraction of cataract in the left eye; normal vision for seven years.*

History.—Mr. W. V. S., aged 49, an inspector of concrete (figs. 7 and 8), was first seen by Dr. Vail, Sr., on March 31, 1924, with a history of failing vision for fourteen months, especially in the left eye. He had always been well. There was no family history of ocular trouble.

Examination.—Right Eye: The cornea was clear, with a horizontal diameter of 13 mm., and a vertical diameter of 12.5 mm. The anterior chamber was very deep. Iridodonesis was present. The pupil measured 2 mm. and responded quickly to light. The pupil could not be dilated wider than 3 mm. in diameter with 2 per cent atropine. The iris was rarefied, although transillumination did not show the concentric rings of light and dark as well as in the other cases. Superficial atrophy of the iris extended to and involved the margin of the pupil

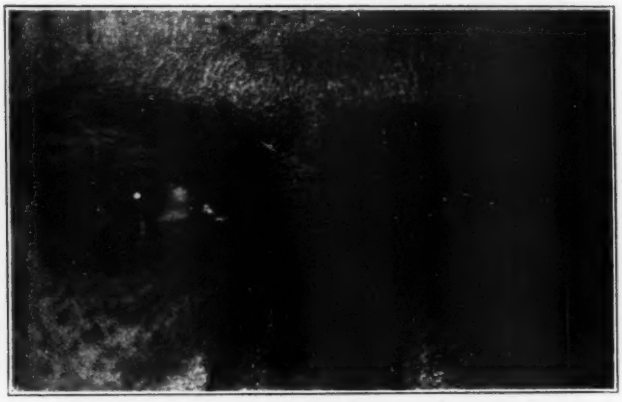

Fig. 7 (case 6).—Megalophthalmus. Note the small pupils and radiating iris fibers.

(fig. 9), so that the retinal pigment showed through a thin semitransparent film. There were no crypts of the iris. The posterior surface of the cornea showed a few fine particles of pigment, but no spindle formation. A tremulous cataractous lens was seen. The patient could count fingers at 6 inches. Projection of light was normal in all parts of the field. The tension was 12 mm. (Souter).

Left Eye: The left eye was an exact counterpart of the right. The cataract was more developed. The tension was 12 mm. (Souter). Projection of light was normal.

Operation.—On April 9, the cataract in the left eye was extracted by Dr. Vail, Sr. An incision with a conjunctival flap was made with the Graefe knife. Iridectomy was performed upward. The anterior capsule forceps were applied, and the capsule was stripped. A normal-sized nucleus was delivered. The rest of the capsule was obtained with forceps. There was no loss of vitreous. Healing was good.

On June 5, vision in the left eye with +9.0 diopters sphere ⌒ +1.50 cylinder axis 15 was 20/20. With the addition of +3.0 diopters sphere the patient could

Fig. 8 (case 6).—Megalophthalmus in the right eye.

Fig. 9 (case 6).—Megalophthalmus. A slit-lamp drawing of the iris. Note the radiating strands, absence of iris crypts and semitransparence of the superficial stroma of the iris.

read Jaeger's test type no. 1. The pupil was clear, and the fundus, field of vision and tension were normal.

On Jan. 20, 1931, the condition of the right eye was the same as before, with possibly more atrophy of the iris.

The condition of the left eye was also the same as before. Vision with the foregoing correction was 20/20+; the patient could read Jaeger's test type no. 1. A few fine floating opacities were seen in the vitreous. The pupil was low, and the pillars were free. The optic disk, fundus and tension were normal.

CASE 7.—*Megalophthalmus; extraction of cataract in the right eye; perfect vision at the end of two years.*

History.—Mr. H. S. VanG., aged 59, an office worker (fig. 10), a brother of the patient in case 8, was first seen by me on Oct. 8, 1928, with a complaint of failing vision in the right eye twelve years before and in the left eye eight years before. At that time a diagnosis of cataract was made. Vision before then had always been excellent. A recent physical examination showed nothing abnormal.

Fig. 10 (case 7).—Megalophthalmus.

Examination.—Right Eye: The cornea was clear, measuring 14 mm. in its horizontal diameter. There was beginning arcus senilis above. The posterior surface of the cornea was peppered with fine particles of pigment. The anterior chamber was very deep, and the aqueous showed many fine particles of pigment floating therein. The iris was atrophied in the superficial portion and very thin. Grayish-blue or slate-colored retinal pigment was seen beneath the atrophied stroma. The remaining iris tissue was arranged in strands radiating to the pupil. The margin of the pupil was atrophied and as translucent as a fish egg. Retro-illumination showed patchy atrophy of the iris, and transillumination showed concentric rings as in figure 5. The pupil measured 3 mm. and responded quickly to light. It did not dilate much with atropine. Iridodonesis was present. A mature yellowish or pigmented tremulous cataract was seen. Projection of light was normal. The tension was 12 mm. (Souter).

Left Eye: The cornea was clear, measuring 14 mm. in its horizontal diameter. Except for absence of atrophy of the iris in a small patch at 12 o'clock, where the stroma of the iris was normal and a golden brown, the eye was an exact duplicate of the right. The cataract was not quite mature. The tension was normal.

Operation.—On October 9, the cataract of the right eye was extracted by me. The Verhoeff conjunctival suture and Van Lint anesthesia of the lids were used. An incision was made with the Graefe knife and a small iridectomy done above. The lens was delivered on the spoon with Smith's counterpressure without loss of vitreous. The lens appeared normal in size, certainly not abnormally large. Healing was excellent.

Dr. Leach of Knoxville, Tenn., prescribed on Nov. 11, 1928, +9.50 diopters sphere ⌒ +2.0 cylinder axis 97. With this lens, vision was 20/20; with the addition of +3.0 diopters sphere, the patient could read Jaeger's test type no. 1. Dr. Leach saw him again on Jan. 23, 1931, and found his vision, with the foregoing lenses, to be 20/20+. He could read Jaeger's test type no. 1.

CASE 8.—*Megalophthalmus; extraction of cataract in the left eye; excellent vision maintained for two and one-half years.*

History.—Mr. H. VanG., aged 55, a furniture dealer (figs. 11 and 12), was first seen by me on May 4, 1928. He was the brother of the patient in case 7. The maternal uncle, now dead, had very large eyes and cataracts; although he suddenly recovered sight in one eye, vision shortly failed, and he became totally blind

Fig. 11 (case 8).—Megalophthalmus.

(undoubtedly complete dislocation of the lens into the vitreous followed by glaucoma, as in couching). The patient complained of failing vision, especially in the left eye, for four or five years. The eyes had always been large. Vision had been excellent up to the age of 40, so that he had shot 130 straight clay pigeons. His general health was very good. Recent physical examination gave negative results.

Examination.—Right Eye: The cornea was clear (slit-lamp) and measured 14 mm. horizontally and 13 mm. vertically. The anterior chamber was very deep. The pupil measured 3 mm. in diameter and responded quickly to light. There was atrophy of the stroma of the iris as far as the lesser ring, which showed crypts and fairly normal stroma. Iridodonesis was present. An immature, pigmented, nuclear cataract was seen. Light was located perfectly. Transillumination showed the typical rings of light and shade. Tension was 12 mm. (Souter). Vision with —6.50 diopters sphere ⌒ —1.0 cylinder axis 180 was 20/100.

Left Eye: The cornea was clear and measured 14 mm. horizontally and 12.5 mm. vertically. There was partial arcus senilis. The anterior chamber was deep. The slate-colored iris was atrophied. (The patient's wife stated that at one time his eyes were hazel.) The pupil was 3 mm. in diameter and responded quickly, but did not dilate more than 1.5 mm. wider with atropine. Iridodonesis

was more marked than in the right eye. There was a nearly mature, pigmented, nuclear, tremulous cataract. The tension was 12 mm. (Souter). Projection of light was normal. The patient was able to count fingers at 4 inches.

Slit-Lamp Examination.—Right Eye: An optical section of the cornea did not show any unusual thinness in the center. The posterior surface showed a few fine particles of pigment deposited thereon. There was no tear in Descemet's membrane. There was atrophy of the superficial layer of the iris as far as the lateral margin of the sphincter, where normal golden yellow or brown iris tissue existed. There was a translucent membrane over the fine straight radiating fibers toward the pupil as far as the sphincter, beneath which could be seen small blood vessels of the iris and brownish retinal iris pigment deep down. Crypts were not seen. The transparent anterior surface showed a few fine dustlike particles of pigment. The margin of the pupil did not show any border of retinal pigment, but rather was as transparent as fish egg or jellyfish. The transparent gelatinous film over the iris gave the bluish, slate-colored tint. The nucleus of the lens

Fig. 12 (case 8).—Megalophthalmus.

showed a diffuse brownish pigment, and many waterclefts were scattered throughout the anterior part of the cortex.

Left Eye: The picture was the same as that of the right eye.

Operation.—On May 5, the cataract in the left eye was extracted by me. The Verhoeff conjunctival suture and Van Lint anesthesia of the lids were used. An incision was made with the Graefe knife and a small iridectomy performed upward. Fluid vitreous presented itself. The lens was delivered on the spoon with Smith's counterpressure, and was about normal in size. There was a slight loss of watery vitreous. Recovery was uneventful.

On June 19, refraction with +7.0 diopters sphere ⊃ +1.75 cylinder axis 10 showed vision of 20/25+. With the addition of +3.0 diopters sphere, the patient could read Jaeger's test type no. 1. A low, black pupil and free iris pillars were seen. The vitreous was clear except for a few stringlike floating opacities. The optic disk was normal; the field of vision and tension were normal.

On Jan. 10, 1931, the patient returned for reexamination. Vision in the eye on which operation had been performed, with +6.50 diopters sphere ⊃ +1.75 cylinder axis 10, was 20/20. With the addition of +3.0 diopters sphere, the

patient could read Jaeger's test type no. 1. The optic disk and fundus were normal. Tension was 12 mm. (Souter). The vitreous showed a few stringlike floating opacities.

COMMENTS ON OPACITIES OF THE LENS AND EXTRACTION OF CATARACTS IN MEGALOPHTHALMUS

In twenty-seven of sixty-nine carefully studied cases (including the author's), opacities of the lens have been mentioned. In most of these cases no description of the type of opacities was given. There were three morgagnian cataracts (Wright, Vail, cases 2 and 3); four definitely posterior subcapsular or complicated cataracts (Kayser, Haab, Salmon, Vail, case 4); two pigmented or cataracts verging on the "black" type (Vail, cases 7 and 8); two of the nuclear type (Vail, cases 1 and 5), and six that presented fine wavy or delicate opacities in the periphery or anterior capsule (Seefelder, Kayser, Kestenbaum, Grönholm [two cases] and Terry). The rest were described as mature, immature or incipient cataracts.

The fact that nine of these cases presented either morgagnian, pigmented or posterior subcapsular opacities indicates that a low grade iridocyclitis had existed previously, and supports the theory advanced by Staehli.

Eight observers have extracted eighteen cataracts with variable results, as will be seen. Terson, in 1888, was the first to remove a cataract in these cases successfully.

Pflüger's two cases are not included in table 2, since the details regarding them were not available, but, according to Kestenbaum, they were both failures.

Operation was successful in twelve of the eighteen cases, and, while the series is too small to justify definite conclusions, the statistics agree favorably with those of extraction of cataract performed in other cases of luxation of the lens. In eleven of the cases the lens was delivered on the spoon or needle; in seven of these there was loss of vitreous varying from a slight to a great amount; four were failures. Three patients had glaucoma before the operation; one case was due to dislocation of the lens into the anterior chamber. Two patients had postoperative iritis; one of them recovered. In three patients retinal detachment developed. Both Terson and Salmon mentioned the escape of a large amount of aqueous after the initial incision, resulting in prolapse of the lens and iris against the posterior part of the cornea, and, together with Koller, they advised a small incision to guard against too rapid emptying of the anterior chamber. I concur in this opinion and believe that a small incision with the Graefe knife and enlargement with scissors is the best method. Wright measured the quantity of aqueous aspirated; he found about 0.6 cc. in a case of megalophthalmus as compared to 0.3 cc. in the normal eye.

TABLE 2.—*Summary of Cases in Which Operation Was Done*

Author	Type of Cataract	Operation and Delivery	Loss of Vitreous	Vision	Comment
1. Terson, 1888	Mature	Simple extraction	None	Excellent	Vision remained good several years
2. Kayser, 1895	Luxation in anterior chamber	?	?	+13.0 D. sph. = 5/60; later loss of sight	Failure; glaucoma due to dislocated lens in anterior chamber; patient 85 years old
3. Kayser, 1910	Mature	Iridectomy	?	Perception of light only	Failure (patient had glaucoma before operation)
4. Haab, 1913	Posterior subcapsular; later mature	Iridectomy and delivery with spoon	Yes	+10.0 D. sph. ⌒ +1.25 cyl. ax. 180 = ¾ — 1; add +4.0 D. sph. = J. 1	Excellent result at end of 2 months
5. Koller, 1919	Not given	Preliminary iridectomy; extraction; needling	None	6/9	Eight years later vision 6/9; good result
6. Koller, 1919 other eye same patient	Not given	Preliminary iridectomy; extraction; needling	None	6/15-12	Corneal opacity; good result
7. Reis, 1920	.....	Iridectomy and delivery with spoon	Yes ++	+10 D. sph. = 6/60; add +4.0 D. sph. = J. 1	Grayish vitreous opacities; good result
8. Reis, 1920; brother of patient in case 7	.....	Iridectomy and delivery with spoon	?	+10.0 D. sph. = counts fingers at 2.5 meters	No details given; failure
9. Salmon, 1920	Posterior subcapsular	No iridectomy; delivery with spoon	None	+11.0 D. sph. ⌒ +0.50 cyl. ax. 180 = 5/12	Developed iritis with keyhole pupil; cleared later with good vision
10. Wright, 1922, R. E.	Morgagnian	Madras method	None	+10.0 D. sph. = 5/20	Fine dustlike vitreous opacities; good result
11. Wright, 1922 case 10, L. E.	Morgagnian	Delivery with needle	Slight amount of thin vitreous	+10.0 D. sph. = 5/30	Fine vitreous opacities; good result; no complications in healing response in either eye
12. Vail, Sr. (case 1)	Mature	Iridectomy; delivery with spoon	None	+10.50 D. sph. ⌒ +1.0 cyl. ax. 90 = 20/25+; add +4.0 D. sph. = J. 1	Excellent vision persisting to patient's death 6 years later
13. Vail, Sr. (case 2)	Morgagnian	Iridectomy; delivery with spoon	Fluid vitreous ++	+14.50 D. sph. ⌒ +1.0 cyl. ax. 90 = 20/40; add +3.50 D. sph. = J. 3	Pupil became updrawn; complete retinal detachment 8 months later; retinal tear; failure
14. Vail, Sr. (case 3; sister of patient in case 2)	Morgagnian	Iridectomy; delivery with spoon	Fluid vitreous +	+14.0 D. sph. = counts fingers at 10 feet	Pupil updrawn; retinal detachment discovered at first dressing 3 days postoperatively; failure; later iridocyclitis
15. Vail, Sr. (case 4)	Posterior subcapsular	Previous trephine and iridectomy; corneal stitch; delivery with spoon	Slight loss of thin vitreous	+12.25 D. sph. ⌒ +4.0 cyl. ax. 5 = 20/40; add +4.50 D. sph. = J. 2	Glaucoma preceding cataract operation; trephine done followed 4 years later by cataract extraction resulting in retinal detachment 6 months later

TABLE 2.—*Summary of Cases in Which Operation Was Done—Continued*

Author	Type of Cataract	Operation and Delivery	Loss of Vitreous	Vision	Comment
16. Vail, Sr. (case 6)	Mature	Iridectomy; capsule stripped with forceps and rest obtained with forceps	None	+9.0 D. sph. ⊂ +1.50 cyl. ax. 15 = 20/20; add +3.0 D. sph. = J. 1	Excellent result; vision after 7 years 20/20+ and J. 1; media clear
17. Vail, Jr. (case 7)	Mature pigmented nuclear	Conjunctival stitch; Van Lint injection; iridectomy; delivery with spoon	None	+9.50 D. sph. ⊂ +2.0 cyl. ax. 97 = 20/20; add +3.0 D. sph. = J. 1	Excellent vision at end of 2 years
18. Vail, Jr. (case 8, brother of patient in case 7)	Mature pigmented nuclear	Conjunctival stitch; Van Lint injection; iridectomy; delivery with spoon	Slight loss of watery vitreous	+7.0 D. sph. ⊂ +1.75 cyl. ax. 10 = 20/25+; add +3.0 = J. 1	Excellent vision at end of 2½ years; few fine stringlike floating opacities

The Van Lint akinesia of the lids together with some form of conjunctival or corneal suture is an important and necessary safeguard, and one should be prepared to deliver the cataract with a spoon if necessary immediately after the incision. In my opinion, a cystotome should not be used, owing to the danger of pushing the lens into the vitreous. If one does not wish to attempt extraction in the capsule, the anterior capsule stripping forceps carefully and gently applied should be used. It seems unnecessary to draw attention to the fact that extraction of cataract should be attempted only in the absence of all signs of glaucoma.

CONCLUSIONS AND SUMMARY

Anterior megalophthalmus is a hereditary, sex-linked, bilateral disease, found almost exclusively in the male sex. It is characterized by enlarged cornea, deep chamber and atrophy of the iris beginning at the periphery and probably progressing toward the margin of the pupil, involving the dilator muscle, but not the sphincter, and results in miosis. Attention is drawn to the peculiar "target" reflex, which seems to be pathognomonic of this atrophic condition of the iris (fig. 5), the zones of which represent the pupil, sphincter, atrophied iris, angle, ciliary body and ora serrata. Harlan, in 1898, described the limited dilatation of the pupil, and also mentioned fine radiating slits in the iris through which the fundus reflex could be seen in his case. Iridodonesis and tremulous lens, which Haab believed due to weakened zonula, are frequently found. There is no evidence of glaucoma, except as possibly developing later in life or as a result of complete dislocation of the lens. The evolution of the disease leads to the development of cataract which is probably always of the cataracta complicata type, and which can be successfully removed with restoration of good useful vision. The operation is more difficult and the complications more frequent than in the normal case.

Considering all of the evidence at one's disposal, I am inclined toward Staehli and Petres' theory that this disease is a hereditary hyperplasia of the cornea, atavistic perhaps, followed by a diseased absorptive, later toxic, process resulting in the end-picture already described. Whether the absorptive process is a result of embryonic activity involving the mesoblastic tissue of the iris extending into middle life as Ormond and Holth believe, or whether the clue to its etiology lies in its association with arachnodactylia and calcium deficiency, is a question which remains for the future to disclose; as does also the question of whether we are dealing with an enlargement of the entire eyeball or just the anterior segment.

819 Carew Tower.

BIBLIOGRAPHY

American Encyclopedia of Ophthalmology, Chicago, Cleveland Press, 1914, vol. 4, p. 2829; 1917, vol. 10, p. 7626.

Axenfeld: Dehiscences and Folds in Descemet's Membrane in So-Called Megalocornea, Klin. Monatsbl. f. Augenh. **43**:157, 1905.

Ball, J. M.: Modern Ophthalmology, ed. 4, Philadelphia, F. A. Davis Company, 1926, vol. 1, p. 441.

Boas, K.: On Megalocornea, Inaug. Diss., Rostock, 1916; abstr., Clin. Ophth. **22**:489, 1917.

Bondi, M.: Two Rare Cases of Congenital Magalophthalmus, Wien. med. Presse **39**:1041, 1898; cited by Kestenbaum.

Carlotti: Hydrophthalmus Congenital, Familial Without Excavation and with Good Visual Acuity, Soc. Ophth Paris, 1906, Ann. d'ocul. **136**:477, 1906; abstr., Arch. Ophth. **37**:139, 1908.

Collins, Treacher: Megalocornea and Microcornea, Tr. Ophth. Soc. U. Kingdom **60**:132, 1920.

A Case of Buphthalmus with Full Vision and Without Any Cupping of Optic Disc, ibid. **33**:193, 1913.

Epinatjew: A Rare Case of Congenital Anomaly of the Eyes, Westphalian Ophth., 1896, p. 6; cited by Kestenbaum.

Franceschetti: Hereditary Eye Diseases, in Schieck, K., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Springer, 1930, vol. 1, p. 727.

Friede, R.: Megalocornea, Arch. f. Ophth. **111**:393, 1923.

Gertz, O.: Demonstration of Two Cases of Megalocornea Congenita, Ophth. Gesellsch., Copenhagen, Dec. 16, 1914; Klin. Monatsbl. f. Augenh. **54**:331, 1915.

Gredig, C.: A New Congenital Form of Megalocornea, Zentralbl. f. Ophth. **17**: 513, 1927.

Grönholm, V.: On Familial Keratoglobus, Finska läk.-sällsk. handl., Helsingfors **58**:1792, 1916.

On the Heredity of Megalocornea Together with a Contribution on the Question of the Genetic Relationship Between Megalocornea and Hydrophthalmus, Klin. Monatsbl. f. Augenh. **67**:1, 1921.

Haab, O.: On Megalocornea, Klin. Monatsbl. f. Augenh. **52**:711, 1914.

Halâsz: A Case of Megalocornea, Ztschr. f. Augenh., 1926, vol. 59; cited by Kestenbaum.

Harlan, G. C.: A Case of Keratoglobus, Arch. Ophth. **27**:199, 1898.

Hird: Enlargement of Eyeball, Ophth. Rev. **32**:137, 1913.

Holth and Berner: Congenital Miosis and Pinhole Pupils Owing to Developmental Faults in Dilator Muscle, Brit. J. Ophth. **7**:401, 1923.

Horner and Michel: Die Krankheiten des Auges in Kindesalter, in Gerhardt: Handbuch der Kinderheilkrankheiten, Tübingen, H. Laupp, 1889, vol 5; cited by Haab.

Igersheimer, J.: Typical Eye Findings in Arachnodactyly, Ber. u. d. 46 Versamml. d. ophth. Gesellsch., Heidelberg, 1927, p. 409; Klin. Monatsbl. f. Augenh. **78**:865, 1927.

Kayser, B.: Megalocornea or Hydrophthalmus, Klin. Monatsbl. f. Augenh. **52**: 226, 1914.

On My Cases of Megalocornea, ibid. **62**:349, 1919.

On the Size of the Cornea in Its Relation to the Globe in Megalocornea, ibid. **64**:292, 1920.

Keiser, J. H.: Size and Growth of Cornea in Childhood, Arch. f. Ophth. **116**: 288, 1925.

Kestenbaum, A.: On Megalocornea, Klin. Monatsbl. f. Augenh. **62**:734, 1919.

Kleinsasser: A Case of True Megalocornea, Arch. Ophth. **55**:205, 1926.

Koller: Megalocornea and Successful Cataract Extraction, Arch. Ophth. **49**:110, 1919; personal communication to the author.

Marklund, G.: Heredity of Megalocornea, Finska läk.-sällsk. handl. **59**:1606, 1917.

Mathewson: A Case of Extreme Megalocornea, Am. J. Ophth. **13**:318, 1830.

Morax: Ocular Pathology, Paris, Félix Alcan, 1929, p. 136.

von Muralt: Hydrophthalmus Congenitas, Inaug. Diss., Zurich, 1869; cited by Kestenbaum.

Ormond, N., and Williams, R. G.: A Case of Arachnodactyly with Special Report of Ocular Symptoms, Guy's Hosp. Rep. **74**:385, 1924.

Owuchi: Megalocornea in Three Generations of One Family, Nippon Gankwa Jakukwai Zasshi, 1913; Ophthalmology **11**:895, 1914.

Peter, Rosa: On Corneal Enlargement and Its Heredity, Arch. f. Ophth. **115**: 29, 1925.

Petres, J.: Clinical Data of Cases of Megalocornea, Orvosi hetil. **73**:84, 1929; Zentralbl. f. d. ges. Ophth. **21**:735, 1929.

Pflüger, L.: On Megalocornea and Infantile Glaucoma, Inaug. Diss., Zurich, 1894; cited by Kestenbaum.

Priestley, Smith: On the Size of the Cornea in Relation to Age, Sex, Refraction, Primary Glaucoma, Tr. Ophth. Soc. U. Kingdom **10**:68, 1890.

Reis, W.: On Megalocornea: Attempt to Explain Its Pathogenesis, Arch. d'ophth. **37**:577, 1920.

Remarks on Friede's Work "Megalocornea," Arch. f. Ophth. **113**:237, 1924.

Salmon, L.: On Megalocornea, Ann. d'ocul. **157**:757, 1920.

Seefelder, R.: On the Relations Existing Between Megalocornea, Megalophthalmus and Congenital Hydrophthalmus, XII Internat. Ophth. Cong., Petersburg, 1914; Klin. Monatsbl. f. Augenh. **56**:227, 1916.

Relation of Megalocornea to Congenital Hydrophthalmus, ibid. **54**:698, 1915.

Remarks on the Megalocornea Question, ibid. **63**:738, 1919.

The Deformities of the Human Eye, in Schieck, K., and Brüchner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 1, p. 593.

Soriano: Megalocornea, Commun. del Hosp. Oft., Buenos Aires **1**:105, 1919; Klin. Monatsbl. f. Augenh. **63**:763, 1919.

Staehli, J.: Clinical Investigation of Microcorneal Eyes, Klin. Monatsbl. f. Augenh. **62**:316, 1919.

On Megalocornea, Klin. Monatsbl. f. Augenh. **53**:83, 1914.

Terry, T. L.: Keratoglobus or Megalocornea, Am. J. Ophth. **13**:144, 1929.
Terson: Rec. d'ophth., 1888, p. 379; cited by Kestenbaum.
Megalocornea, Toulouse méd. **22**:217, 1921.
Thaden, F.: A Case of Arachnodactyly, Arch. f. Augenh. **100-101**:278, 1929.
Tron, E.: Variational Investigation (Statistical) on Refraction, Arch. f. Ophth. **122**:1, 1929.
Vogt: Megalocornea, Ztschr. f. Augenh. **58**:381, 1926.
Warlomont: Two Cases of Bilateral Buphthalmus with Conservation of Good Vision, Ann. Soc. scient. de Bruxelles **21**:2, 1896; cited by Kestenbaum.
Wright: Megalophthalmus and Microphthalmus, Brit. J. Ophth. **6**:35, 1926.

ABSTRACT OF DISCUSSION

DR. EDWARD J. CURRAN, Kansas City, Mo.: I think that in his paper Dr. Vail has shown that this condition deserves a special place in textbooks and medical literature. I like the name he uses, "megalophthalmus anterior." There seems to be doubt in the minds of some physicians as to whether the whole eyeball is enlarged. I have been measuring the cornea and the transverse diameter of the eyeball for a long time, and I believe that the eyeball is not enlarged generally in these cases.

Another point I wish to make is that although these patients may not have a glaucoma, they have a predisposition to it, and in embryonic life they had some condition simulating glaucoma, possibly an increase of tension, not sufficient to stretch the cornea, but sufficient to cause an increase in the growth of the anterior segment.

Let us look at what happens in embryonic life when there is arrested development. If it occurs in all the structures of any organ smallness of that organ results; but if there is arrested development in only part of the structures, the organ as a whole is not affected. I shall try to make that clear: When the opposite condition to that discussed by Dr. Vail is present, namely, microphthalmus, arrested development means a small eye in all its parts. In early embryonic development the supportive tissue of the vitreous predominates; therefore megalophthalmus anterior results. As the vitreous is not quite formed, it may offer resistance. The essential fact in megalophthalmus anterior is that it appears at a certain stage of embryonic development, and that stage coincides somewhat with the time that this supportive tissue predominates. Then the aqueous forms, perhaps causing just enough pressure to enlarge the cornea. In the first place, at a certain stage the cornea is large in embryonic life, and that perhaps explains this enlargement in infants with maldevelopment of the filtration angle. Any slight increase of pressure here would not be conveyed back to the eye because of the predominance of supportive tissue over fluid. Therefore enlargement of the cornea might occur instead of a cupped disk or enlargement of the posterior segment of the eye. This enlargement goes on until there is a balance. The balance of fluid in the eye depends on the increase of the cornea and the increase in size of the canal of Schlemm, in other words, the scleral ring. Then the balance may be arrested for a time. The cornea is large, and the anterior chamber is deep, both of which favor filtration. One may have a cornea 8 mm. greater than normal, and in that case the size of the scleral ring lengthens to 25.12.

DR. JONAS S. FRIEDENWALD, Baltimore: Dr. Vail's beautifully clear and detailed report of this interesting and unusual condition leaves small occasion for discussion or comment. I have nothing to add to the clinical aspect of his report, except, perhaps, to emphasize the rarity of this condition. When I was asked to

prepare a discussion on this subject, I went through the records of the Wilmer Institute and also those of my father's office practice. No case similar to Dr. Vail's was found. Naturally, I have not seen such a case myself, and I should judge that the vast majority of those present today are in the same state of blissful ignorance as myself.

A few words may be said, however, on the genetic aspect of this problem. Mutants with excessively large, but otherwise normal organs of various kinds, are well known in many species of animals. When genetics is mentioned, one naturally turns first to the fruit fly; a variety of fruit flies has been discovered with excessively large eyes. Such exaggerations are explained in two ways. Sometimes a gene may mutate, yielding a new gene, which has a more intense effect than the unmutated gene. On the other hand, owing to an unequal crossing over of chromosomes, one offspring sometimes may get a double dose of the genes concerned in a given function. Either of these two mechanisms can apparently produce an exaggeration of a normal characteristic.

Dr. A. Edward Davis, New York: I wish to report a case that I think may be classed with the cases of these patients of Dr. Vail.

A youth, J. B., aged 19, was in good health; his father and mother were living and had good eyes. The patient had bilateral megalocornea, the diameter of each cornea being 15 mm. The radius of the right eye in the horizontal meridian was 8.5; of the left eye, 8.6. These are very long radii. The corneas were clear, with well defined margins and no striae on Descemet's membrane, as revealed by the slit lamp. The anterior chamber was moderately deep; the pupils were about 3.5 mm. in diameter. There was no sign of atrophy of the iris or lens opacity. Vision in the right eye was 20/15—; in the left, 20/15. The patient was practically emmetropic. The lens were clear, the fundi normal and the tension 15 by the Schiötz tonometer. The eyes appeared normal except for the large cornea.

Dr. Carl Koller, New York: I have seen a number of cases of megalocornea of the nonglaucomatous type, but I have given treatment and operated in only one case of cataract in megalocornea. This was in 1918, and not knowing of any other cases, I naturally felt considerable trepidation concerning the operation.

The following procedure was adhered to in both eyes with success. The progress made since that time with the intracapsular extraction might change the method in some respects.

First, I performed a preliminary iridectomy, making a small lance incision and withdrawing the lance slowly, so that only part of the aqueous would run out, and that slowly. The chamber did not fill again at once, so that liquid vitreous could be ruled out. However, after excising the iris, the chamber filled with blood, very likely from the partially atrophic iris. It is remarkable that this bleeding occurred every time after the four operative interventions, two iridectomies and two extractions. That it did not come from the distended sclerocorneal margin is made probable by the fact that similar hemorrhages occurred after perforation of an ulcer in the thinned center of the cornea, which happened in one eye before any operation, and in the other, between operations, and quite independently from them. The hyphema absorbed readily in every case.

The extraction was done in the following manner: First, I circumcised the cornea in its upper half and undermined the conjunctiva, putting two stitches in place and carrying them through the lower limbus, so as to be able to pull the conjunctiva like a cap quickly over the cornea at the completion of the extraction. A small section was made with a Graefe knife at the opaque border, and liberally enlarged to both sides with the Stevens scissors, the object being to drain the aqueous slowly. After capsulotomy, the lens, large, sclerosed and amber colored,

was easily extracted. None of the expected escape of liquid or solid vitreous occurred. The conjunctival flap was pulled down, and the stitches knotted. The eye presented a remarkable appearance. It looked more like a cylindric than a spherical drygoods parcel, constricted by the sutures. Recovery was uneventful, and the visual result good, marred only by the old corneal opacities.

Dr. David W. Wells, Boston: I wish to report a case of megalocornea and arachnodactylia (infantile) seen on Dec. 26, 1929, in a male child, aged 48 hours, who was born with normal delivery. Both corneas were as large as those of an adult; almost no sclera was seen. The right palpebral fissure was narrow, the pupil 2 mm., the cornea clear; the left palpebral fissure was from 5 to 6, the cornea very hazy, and the pupil seen with difficulty. Both eyes closed as light was approached. At that time infantile glaucoma was suspected but increased tension was not found.

The father was an Italian, and the mother a Newfoundlander. Two years before, the mother had given birth to a healthy girl. Neither the father nor the mother had any refractive error of moment, and there was no knowledge of any ocular disease in the grandparents.

Five days after birth, the child's eyes became inflamed, discharging pus. On January 3, the right eye was slightly inflamed. There was a discharge of mucus from the left eye. The lids were somewhat swollen. This proved to be a mild inflammatory attack, lasting a couple of weeks.

On January 4, the laboratory report was negative for gonococci; many pus cells were present but no organism was found. On January 6, culture from the right eye showed staphylococci.

After a month both corneas had cleared. The anterior chambers were very shallow, the pupils, 2 mm.; with atropine, the right pupil was about 3 mm. crenated; the left, 3.5 mm. No vessels or nerve was visible in either eye. Tension was normal.

In June, 1930, after atropine was used for five days, the right pupil was 2.5 mm. and the left pupil 3 mm. The right was crenated and the left round. There were red reflexes, but no fundus details, as I could not keep the eyes still enough for a good observation. The diameter of the right cornea was 10 mm., of the left 13 mm. This time a diagnosis of megalocornea was made on the basis of material on the subject in the encyclopedia of ophthalmology.

On June 6, the diameter of the right cornea was 13 mm.; of the left, 14 mm. After three applications of atropine in twenty-four hours, the right pupil was 2 mm. crenated, the left pupil 3 mm. round. The eyes followed light in all directions. The sclerae were white. The mother called attention to the spider fingers and toes typical of arachnodactylia. Some defect in the feet was noticed by the nurse at birth. Vision for near objects was apparently good. At 17 months, the face was as well formed and mature looking as that of a child of 6 years.

Dr. F. H. Verhoeff, Boston: Since Dr. Vail wrote his paper, he has operated on a patient and removed a piece of iris by iridectomy; he sent it to me for examination, and asked me to describe what I found.

The iris showed very few chromophores, these being confined to the anterior boundary layer. The most important thing was a large lymphocytic nodule in the region of the sphincter. This proves that there was some irritative condition in the eye, which accords with the fact that in these cases there is a tendency to fluid vitreous and postcortical cataract. Whether the irritative condition may depend on a degenerative condition, I do not know.

Dr. John E. Weeks, Portland, Ore.: Figure 7 in Dr. Vail's article reminds me of a similar case that came under my observation a number of years ago. The

patient, a woman of about 40 years of age, had previously consulted ophthalmic surgeons in Philadelphia. The corneas were large — I have forgotten the exact diameter. The pupils were very small and there was little or no reaction to light, showing, in my opinion, atrophy or paralysis of the dilator pupillae muscle. On examination, I found the projection to be good, the retinas apparently functioning normally.

I operated on both eyes for the removal of cataract, with an interval of ten days between the operations, obtaining vision of 20/20 in each eye.

Dr. Derrick T. Vail, Jr.: Dr. Curran's theory is most interesting and likely can be accepted as on the right track to the true explanation. However, the fact that both eyes were equally affected would indicate that if there were a simultaneous arrested process, the same pathologic phenomena would ensue, otherwise one eye might be arrested and the other develop normally.

Dr. Friedenwald touched on the genetics, and I have nothing to add.

Dr. Davis' case presented the highest rate of corneal curvature I have been able to find in the literature.

Dr. Koller's technic is good; the eyes were saved, so the results are excellent.

I do not know what the condition was in Dr. Wells' case, but I do not think it falls into the category under discussion. The shallow anterior chamber as well as the healthy cornea at birth would rule out such a diagnosis.

Dr. Verhoeff's pathologic examination bears out the finding of progressive irritation of the iris.

THE CLINICAL USE OF THE SANDER PUPILLOSCOPE *

SANFORD R. GIFFORD, M.D.
AND
LEO L. MAYER, M.D.
CHICAGO

With the invention of the differential pupilloscope by Hess [1] and the careful studies by him and his pupil Groethuysen,[2] a new basis was created for the study of the pupillary reactions and for the exact localization of lesions in the reflex arc. The use of this instrument and its value in the study of neurologic cases has been well presented in this country in the papers of O. Barkan [3] and Adler.[4] These authors pointed out that the Argyll Robertson pupil may be detected by means of this instrument at a stage when an ordinary examination of the pupil gives no definite findings, and that in many cases the location of lesions or the detection of multiple lesions in the reflex arc is possible only by the use of the pupilloscope. The progress of such lesions during treatment may also be accurately checked by this means, whereas subjective estimations of more or less "sluggish" pupillary reactions are notoriously unreliable.

The use of the pupilloscope, however, has remained limited chiefly to a few clinics in which large numbers of neurologic cases are studied. This is apparently due in part to the cost and bulk of the Hess instrument and to the time consumed in making examinations with it.

In 1925, Sander [5] described a simplified "Zusatz-Pupilloskope" with which the same accurate examination of the pupillary reaction can be carried out, which may be attached to the ordinary Zeiss corneal microscope and the cost of which is much less than that of the Hess instrument.

The essential part of the instrument is a gray glass plate, 22 by 72 mm. in size, which is divided into an upper and a lower half. The upper half is dark gray, transmitting only 2.3 per cent of the light, while the lower half is graduated from a light gray transmitting 55 per cent of light to the same dark gray as that of the upper half. The plate is mounted before a 0.4 ampere, 3.5 volt lamp with a slit aperture and collecting lens in such a way that it may be moved up by a

* Submitted for publication, April 4, 1931.

* From the Department of Ophthalmology, Northwestern University Medical School.

1. Hess: Arch. f. Augenh. **80**:213, 1916.
2. Groethuysen: Arch. f. Augenh. **87**:152, 1921; **88**:83, 1921.
3. Barkan, O.: Differential Pupilloscopy, Arch. Ophth. **51**:29 (Jan.) 1922.
4. Adler, F. H.: Pupilloscopic Findings in Lesions in Different Parts of the Reflex Arc, Arch. Ophth. **55**:262 (May) 1926.
5. Sander: Klin. Monatsbl. f. Augenh. **83**:318, 1929.

push-button, so that first the upper half and then the lower half of the glass plate is before the slit. The light throws a round beam which just covers one eye, and may be adjusted by movement on a quadrant. Movement of the glass gives a difference in the intensity of the light which is measured by a scale at the upper edge of the glass plate, 1 representing the maximum difference and 21 no difference. A scale is furnished with the instrument by which the percentage of light transmitted at different points is expressed as a decimal, but in practice it is only necessary to know that every normal pupillary apparatus reacts to the very slight difference represented by 19 to 16 on the scale. Starting with the lower numbers, which should produce a marked reaction, the plate is pushed along till the last perceptible reaction is observed, which is recorded. The room should be semidark, and the patient should fix his gaze on the observer's forehead, so that his accommodation will not change. Slight movements of the eyes at the moment when the reading is made may simulate a reaction to light. Another possible cause of confusion is a slight contraction of the pupil caused by the movement of the shutter itself, probably because the eye tries to follow it. This usually occurs only during the first few readings and varies in extent. It does not occur repeatedly and equally with the same difference in light, as is the case with a true reaction to light.

The Sander instrument was devised to fit the Zeiss corneal microscope, and Sander advised observation of the pupil with the low magnification of this instrument (objective 2, ocular 5, magnification $\times 8$). We have found, however, that it is simpler to use the binocular loupe magnifying about 4 times and to dispense entirely with the corneal microscope. For this purpose it was necessary to replace the upright for the corneal microscope with a brass rod drilled to hold the pupilloscope (fig. 1). The whole rod with the pupilloscope is removed by loosening one screw, and is kept connected with the rheostat in a box so that its replacement consumes only a few seconds. If one has no Zeiss corneal microscope, it should not be difficult to arrange an adjustable stand for the pupilloscope. An advantage of the Zeiss slit-lamp corneal microscope is that the slit-lamp is left attached to the table and is used to give a constant illumination while the consensual reaction is tested.

Another attempt to simplify and to render the examination of the pupillary reaction more accurate has been made by Engel.[6] His pupilloscope produces a measured change in the intensity of the light stimulus by a change in the electrical resistance. This eliminates the movement of the glass shutter before the eye, which is, however, not a serious source of inconvenience.

6. Engel: Arch. f. Augenh. **103**:657, 1930.

Lehrfeld [7] recently demonstrated an improved instrument which shows the pupillary response to light by measuring the intensity accurately in candle power. From the description the flexibility of his instrument seems limited.

Our routine procedure with the Sander instrument is as follows: The pupilloscope is fixed on the right eye. The right direct reaction is read, for example, R. D. 19. The slit-lamp is then turned on the left eye and the left pupil is observed while the varying light of the pupilloscope is thrown on the right pupil. This gives the left consensual reaction, for example, L. C. 14. The last point at which the right eye can distinguish the difference between the degrees of light is also recorded, for example, R. V. D. A. 19. (This is the visual discriminative acuity, in distinction to the motor discriminative acuity, or ability to respond to a difference in light with a pupillary reaction. Visual and motor discriminative acuity are the same in normal persons but may show marked discrepancies in pathologic cases.)

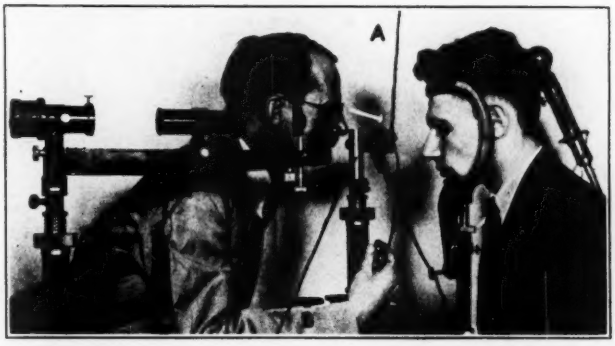

Fig. 1.—Pupilloscope on stand for use with loupe. Right eye is being examined; slit-lamp is in place for subsequent illumination of the left eye to record consensual reaction: *A*, pupilloscope; *B*, column that replaces attachment to corneal microscope.

The pupilloscope is now fixed on the left pupil and the same readings are made, for example: left direct reaction, L. D. 14; right consensual reaction, R. C. 19, and left visual discriminative acuity, L. V. D. A. 19. The convergence reaction may be conveniently recorded on both eyes at the same time. The data are tabulated as follows:

R.D. 19	L.D. 14
R.C. 19	L. C. 14
R.V.D.A. 19	L.V.D.A. 14
Right convergence present	Left convergence present

It will be seen from the accompanying diagram of the pupillary pathways (fig. 2) that the reduced left direct and left consensual reaction indicates a lesion in the afferent fibers from both sides after their

7. Lehrfeld: Arch. Neurol. & Psychiat. **25**:159 (Jan.) 1930.

separation from the optic tracts and before reaching the left oculomotor nucleus (at *7* in fig. 2). These are the so-called intercalated fibers that are assumed to be injured in the Argyll Robertson pupil. A reduction of the left direct and right consensual reactions, on the other hand, would indicate a lesion in the left afferent fibers before their decussation. This would usually be accompanied by a reduction in visual discriminative acuity of the left eye, which would indicate a lesion anterior to the external geniculate body. If vision and visual discriminative acuity are not reduced, however, this would indicate a lesion of the intercalated fibers between the external geniculate body and their decussation (*6* and *6a* in fig. 2). Such lesions are apparently rare in syphilis of the central nervous system, but may occur, as in our case 17. In a number of the

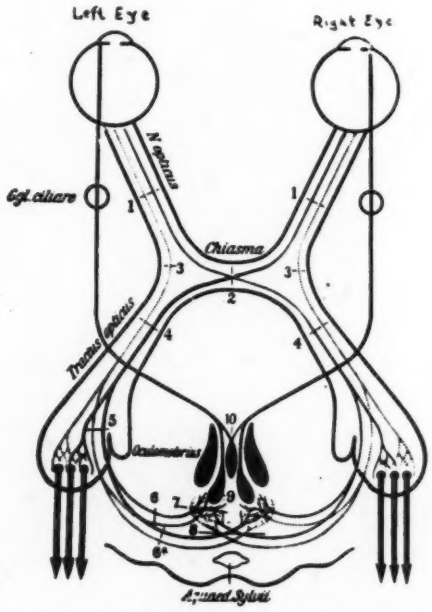

Fig. 2.—Diagram of the pupillary pathways (after Bernheimer): *1*, lesion of the optic nerve; *2*, sagittal lesion of the chiasm; *3*, lesion of the chiasm on its lateral side; *4*, lesion of the optic tract; *5*, lesion of one entire pupillary fiber tract at external geniculate body; *6*, lesion of pupillary fibers to homolateral sphincter nucleus; *6a*, lesion of pupillary fibers to contralateral sphincter nucleus; *7*, lesion of pupillary fibers from both sides to one sphincter nucleus; *8*, lesion of pupillary fibers from both sides to both sphincter nuclei; *9*, lesion of sphincter nucleus for light reaction; *10*, lesion of sphincter nucleus for convergence reaction.

cases subsequently listed, the visual discriminative acuity was not recorded. This should be a part of the routine examination as it may be of help in localization. The amount of central vision, as a rule, but not always, is roughly parallel to the visual discriminative acuity. Lesions of the intercalated fibers alone are accompanied by miosis, the presence of left mydriasis with reduced left direct and left consensual

Data on Patients Examined with the Sander Modified Pupilloscope

Case; Patient	Diagnosis	Pupilloscopic Observations*		Vision	Comment
1 C. S.	General paresis, tabetic type	R.D. 4 R.C. 0 Bilateral convergence reactions present	L.D. 6 L.C. 0	Right 1.2 + 4 Left 1.2 + 4	Bilateral Lesion at 6a (fig. 2): complete Lesion at 6: partial
2 R. M.	Tumor of cerebellopontine angle	R.D. 16 R.C. 17 Bilateral convergence reactions present	L.D. 17 L.C. 13	Right 1.5 — 4 Left 1.2 + 1	Lesion at 6a: partial (on right side)
3 M.K.	Tabes	R.D. 0 R.C. 0 R.V.D.A. 0	L.D. 0 L.C. 0 L.V.D.A. 2	Slight perception of light in both eyes	Lesion at 8 involving direct and consensual tracts or at 1 bilaterally
4 J. K.	Suspected syphilis of central nervous system	R.D. 16 R.C. 16	L.D. 13 L.C. 13	Right 1.5 Left 1.2 — 4	Lesion at 7: partial
5 H. G.	Cerebral arteriosclerosis; hypertension	R.D. 14 R.C. 12	L.D. 12 L.C. 14	Right 0.8 Left 0.8	Lesion at 5: bilateral
6 A. R.	Multiple sclerosis	R.D. 13 R.C. 12	L.D. 13 L.C. 9	Right 8/200 Left 8/200	Lesion at 1: bilateral
7 H. B.	Subdural hematoma	R.D. 6 R.C. 4	L.D. 12 L.C. 6	.....	Lesion at 7 and 6a (right)
8 A. B.	Suspected syphilis of central nervous system	R.D. 17 R.C. 17 Bilateral convergence reactions present	L.D. 0 L.C. 0	Right 1.5 — 4 Left 1.5 — 4	Lesion at 9 (left) (mydriasis)
9 D. D.	Suspected syphilis of central nervous system; hysteria	R.D. 16 R.C. 16	L.D. 16 L.C. 16	Right 1.0 + 3 Left 1.0 + 3	Negative Wassermann reaction; right pupil larger than left
10 F. S.	Congenital hydrocephalus; optic atrophy	R.D. 16 R.C. 13	L.D. 17 L.C. 13	Right 0.2 Left 0.1	Lesion at 6a: bilateral
11 H. P.	Suspected traumatic epilepsy	R.D. 19 R.C. 18	L.D. 19 L.C. 18	Right fingers at 3 feet Left 0.5	Poor vision all his life; myopia at age of 20; no lesion of pupillary pathway
12 W. J.	Retrobulbar neuritis	R.D. 14 R.C. 18	L.D. 18 L.C. 17	Right 18/200 Left 20/200	Lesions at 1
13 R. S.	Suspected pituitary tumor	R.D. 16 R.C. 15 Bilateral convergence reactions present	L.D. 16 L.C. 15	Right 1.2 + 2 Left 1.2 + 2	Patient seemed defective; fields essentially normal
14 J. O.	Optic atrophy	R.D. 0 R.C. 0 Bilateral convergence reactions present	L.D. 0 L.C. 0	Right 0.3 Left 1.0 Pupils 4 mm. in size	Lesion at 8: Wassermann reaction 4+
15 G. H.	Taboparesis	R.D. 19 R.C. 15	L.D. 12 L.C. 13	Right 1.5 Left 1.5	Lesion at 7; questionable lesion at 6a (left)
16 J. O.	Dementia paralytica	R.D. 11 R.C. 7	L.D. 7 L.C. 7	Right 1.5 — 2 Left 1.5	Lesion at 7 and 6a
17 R. A.	Syphilis; Bell's palsy; eighth nerve deafness	R.D. 15 R.C. 16	L.D. 16 L.C. 12	.....	Wassermann reaction 4+; gag reflex absent
18 J. R.	Conjunctivitis; partial atrophy (right)	R.D. 19 R.C. 18	L.D. 19 L.C. 19	Right 0.5 — 2 Left 1.5 — 3	Hit in right eye 9 years before; no lesion
19 T. M.	Hemiparesis	R.D. 16 R.C. 11	L.D. 11 L.C. 16	Right 1.2 — 4 Left 1.2 — 4	Lesion at 5 (left); convergence normal
20 H. C.	Optic atrophy	R.D. 14 R.C. 15 R.V.D.A. 1	L.D. 15 L.C. 14 L.V.D.A. 14	Right 0.3 Left 7/200	Left homonymous hemianopia; lesion at 4; bilateral
21 J. D.	Cerebral hemorrhage; optic atrophy; hypertension	R.D. 10 R.C. 7	L.D. 7 L.C. 0	Right: hand motions at 2 in. Left; fingers at 2 ft.; blood pressure, 230/160	Lesion at 1; bilateral
22 M. B.	Syphilis	R.D. 14 R.C. 14	L.D. 16 L.C. 16	.....	Lesion at 7 (right)
23 A. T.	Vascular lesion of the brain on left side	R.D. 13 R.C. 3	L.D. 16 L.C. 13	Right 1.0 + 3 Left 0.8 + 2	Lesion at 6, 6a and 7 (right)
24 B. Mc.	Left convergent strabismus; amblyopia (left)	R.D. 19 R.C. 11 Right convergence reaction sluggish; left negative	L.D. 0 L.C. 0	Right 1.5 — 4 Left 3/200	Lesion at 7 and 6a (left)
25 F. C.	Primary optic atrophy; syphilis	R.D. 0 R.C. 0	L.D. 0 L.C. 0	Right 0.3 + 2 Left no pl	Lesion at 8: complete

* R.D., right direct reaction; L.D., left direct reaction; R.C., right consensual reaction; L.C., left consensual reaction; R.V.D.A., right visual discriminative acuity; L.V.D.A., left visual discriminative acuity.

reactions, as in case 8, indicating involvement of the left oculomotor nucleus for the light reaction (*9* in fig. 2).

We have examined a number of patients with the Sander instrument. Normal persons always showed a direct and consensual reaction between 16 and 19, and usually nearer 19, and a visual discriminative acuity of about 19. The observations in twenty-five cases showing neurologic lesions or in which these were suspected are listed in the table.

Normal data are not listed in the table, except when they are interesting because of the presence of some neurologic disease.

The scheme of the pupillary mechanism used is that of Bernheimer. This was chosen as covering the possibilities as well as any other, though it is recognized that no such scheme corresponds to anatomically proved facts. This means that some of the exact localizations suggested for our cases are of only theoretical interest, since they cannot be proved. It may be possible, however, that some of these may be proved or disproved in cases that come to autopsy, in which event definite information about the reflex arc may be obtained.

Cases 9, 11, 12, 13 and 18 varied only slightly, or not at all, from the normal, thus illustrating what may be expected in such types.

Cases, 3, 4, 5, *22*, 24 and 25 may be grouped together as showing various stages in syphilitic infection with Argyll Robertson pupils. The patient in case 4 had an early Argyll Robertson pupil and had undergone much treatment. The notation on the history sheet made by the medical examiner was: "the left pupil seems slightly sluggish." The patient complained of constriction pains all over the body; the right knee jerk was sluggish, and the left absent; the pupils were small, with normal reaction to accommodation. Case *22* was similar. In case 5 the left pupil was larger than the right; serologic examination of the blood and spinal fluid gave negative results; a good accommodation reaction was obtained. Case 24 yielded negative results in examinations of the blood and spinal fluid. The accommodation reaction was sluggish in the right eye and absent in the left. Cases 3 and 25 were the result of long-standing or more rapid involvement of the central nervous system by the spirochete. Examinations of the spinal fluid gave positive results and showed characteristic colloidal gold curves. The pupils were of pinpoint size, and the measurement of the visual discriminative acuity in case 3 demonstrated how greatly the sensory portion of the optic nerve was involved.

Reduction of the direct reaction in one eye and the consensual reaction in the other eye was shown in cases 2, 5, 6, 17, 19 and 21, and to a certain degree in case 23. Of the seven in this group, five (2, 5, 19, 21 and 23) might be considered as having a vascular basis; in these no infection was noted. Of the remaining two patients, one was syphilitic and the other had multiple sclerosis. A 4 diopter papilledema of both eyes, both horizontal and vertical nystagmus, clumsiness of fine move-

ments of the left hand and an increased knee jerk on the left side were found in case 2. The findings in case 5 were: blood pressure, 240 systolic and 130 diastolic; weakness of the extremities; exaggeration of deep reflexes; defective memory for recent events; general arteriosclerosis and a negative Wassermann reaction.

A complete lesion at *8* on the diagram (fig. 2), together with partial destruction of the optic nerves, was shown in cases 14 and 25.

A lesion of the optic tract at *4* (fig. 2) was shown in case 20 in which there was a left homonymous hemianopia, but neurologic examination failed to reveal anything but slightly exaggerated reflexes on the left side. Serologic examination yielded negative results.

In case 10 we were able to show that in spite of optic atrophy the visual discriminative acuity was greater than the motor discriminative acuity.

A similarity was found in cases 1, 7, 15 and 16 in the fact that the direct and consensual reactions of both eyes were decreased. Also all showed syphilitic infections of long standing and no evidence of involvement of the sensory portion of the visual apparatus. Case 15 and several others illustrate the detection and definite recording of lesions of the reflex arc at a stage when they would easily be missed by the usual examination of the pupils.

Case 24 is interesting, as showing an apparent defect of development in the receptor apparatus of the pupil, associated with congenital amblyopia. That the defect of development involved the reflex arc is shown by a definite reduction in the right consensual reaction. The ease and accuracy with which the consensual reaction may be examined with the pupilloscope is one of the great advantages of this method over others, in which such an examination may offer difficulties.

CONCLUSIONS

1. It is believed that a pupilloscopic examination greatly adds to the value of the information that one is able to obtain with respect to lesions of the pupillary apparatus.

2. Early stages of the Argyll Robertson pupil may be detected before they are recognizable by an ordinary examination, and exact records may be kept, which may be checked for progress of the condition.

3. Such records when compared with observations at autopsy in certain cases may afford information as to the anatomy of the pupillary pathways.

4. The Sander Modified Pupilloscope is a simple and time-saving instrument for this purpose.

5. It is hoped that the wider use of pupilloscopic observations may establish standards for more exact examination of the pupillary reactions and interpretation of these data.

RETAINED PUPILLARY REACTIONS WITH NO PERCEPTION OF LIGHT

REPORT OF A CASE *

SANFORD R. GIFFORD, M.D.
AND
LEO L. MAYER, M.D.
CHICAGO

Lavada B., a girl, aged 15, was first seen at the Northwestern University Eye Clinic on Sept. 9, 1930. She stated that vision had been lost in the left eye following a wound with a nail at the age of 5. She believed that no perception of light had been present in the left eye since that time.

Examination showed the right eye to be normal, with a vision of 20/20, normal pupillary reactions and a normal fundus. The left eye showed a shrunken white cataract, through which no reflex of the fundus could be obtained, and a small scar below and away from the center of the cornea. A divergent squint of 20 degrees was present. No perception of light was present on repeated testing. The left pupil reacted not only to convergence and consensually to light thrown on the right eye, but directly to light. Not only was there a definite direct reaction to light, but with the Sander Differential Pupilloscope it could be shown that the reaction was obtained with a difference in light corresponding to 19 on the scale; the same amount was required by the right eye. The right pupil reacted consensually to light thrown on the left eye, when the difference in light was equally low (19 on the scale). In other words, although visual impressions of light were not perceived, motor discriminative acuity, or the ability of both pupils to react to light thrown on the left eye was normal.

The results of general examination and the history were without bearing on the ocular conditions, and the Wassermann reaction was negative. There was no economic reason for her concealing the presence of vision in the left eye.

The observation of this case brings up the much debated question of whether or not the pupillary reaction to light is mediated by a different mechanism from that transmitting the sensation of vision. It was the report of such cases, with a marked difference between vision and the reactivity of the pupil, which first made it appear necessary to assume a separate mechanism.

A review of the literature fails to show many reports of persons who, in spite of their inability to recognize light, still have a reaction of the pupil to light. The usual teaching, especially when malingering is suspected, is that if the pupil reacts to the light stimulus the patient should be able at least to see the light, whether the fundus is abnormal

* Submitted for publication, April 4, 1931.

* From the Department of Ophthalmology, Northwestern University Medical School.

or not. In this connection Spaeth's [1] recent article is of interest. He quoted Janet and McAuley, who studied pupillary reflexes in malingering, as follows:

> These are absent in true blindness (McAuley), except (*a*) when the lesion is high up in the optic pathways above the fibers of the reflex arc to the center for pupillary movement, (*b*) in bilateral lesions of the occipital cortex, (*c*) in temporary retainment in uremia with amaurosis, (*d*) in blindness from certain diseases of the optic nerve wherein it seems that the pupillary fibers for the light reflex were more resistant than the visual fibers and (*e*) in that reaction described by Leber with certain forms of retinal degeneration wherein a slow reaction to light remains even with total absence of light perception.

Bodenheimer and Korbsch,[2] in attempting to determine whether there is a pathway outside the retina by which pupillomotor reactions are carried, reported a case of amaurosis of one eye with maintenance of pupillary reflex. They found only about fifteen such cases reported—the first one by Albrecht von Graefe—but noted that more recent investigators, such as Bumke and Hess, questioned the proofs of the older recorders. (Their patient was a girl, aged 23, who had been referred with a diagnosis of functional amaurosis and hysteria. The right pupil was wider than the left and there was no perception for light in the right eye; the visual acuity of the left eye was perception of fingers. A physical examination including a Wassermann test gave negative results. Both disks, however, showed a slight papilledema. The right pupil reacted promptly to light directly and consensually. The left pupil reacted slowly to light, and the consensual reaction was noted as present. The pathologic report led to the conclusion that the fibers of the reflex arc were spared.)

Magnus,[3] in discussing pituitary tumors, mentioned three cases of bitemporal hemianopia in which he was able to demonstrate a pupillary reaction when light was thrown on the nasal side of the pupil.

Wirth [4] reported a case of suspected internal hydrocephalus in a girl, aged 12, with optic atrophy of the right eye when first seen. Her headaches suddenly grew worse, and for a week she had no perception of light in the left eye. In spite of the amaurosis the pupil reacted promptly to a direct stimulus but not consensually. Later vision returned slowly, and a large central scotoma was found.

Alexander,[5] in a discussion of Parson's paper on pupillary reflexes, told of a patient with a retained pupillary reaction in an amaurotic

1. Spaeth, E. B.: Differentiation of Ocular Manifestations of Hysteria and of Ocular Malingering, Arch. Ophth. **4**:911 (Dec.) 1930.
2. Bodenheimer and Korbsch: Arch. f. Ophth. **121**:46, 1928.
3. Magnus: Arch. f. Ophth. **121**:225, 1928.
4. Wirth: Klin. Monatsbl. f. Augenh. **73**:251, 1924.
5. Alexander: Tr. Ophth. Soc. U. Kingdom **44**:45, 1924.

eye, but he failed to give a complete report. Textbooks on ophthalmology have for the most part nothing or very little to say concerning this condition. Axenfeld [6] stated: "The light reaction may remain if the loss of vision has its seat above the optic nucleus, above the geniculate body, in the optic radiations or in the occipital cortex; also in the central amaurosis found in uremia, and in hemianopsia when the blind half of the retina is stimulated."

Of the German writers, Hess and Behr undoubtedly investigated this field more thoroughly than any others. Behr [7] reported a case of tower skull in a man aged 40. In the right eye vision was limited to perception of fingers at 1 meter, while the left eye was blind. Direct and indirect reactions to light were present in each eye, but were not so extensive in the left. In a second case, a boy aged 9 had choked disks and no perception of light. The reaction of both pupils to light was prompt and extensive, even to weak light. After several months atrophy occurred, and the reaction to light disappeared. These were the only cases of this nature seen by Behr in 40,000 observed over a period of five and one-half years. The possibility of reaction to light being provoked by direct stimulation of the iris is excluded in the second case as the reaction disappeared with the development of atrophy. Evidently the pupilloscope was not used, but these patients were examined according to Hess' requirements as to (1) strength of light, (2) distance and (3) maintenance of the same angle of entrance and state of adaptation. Behr contended that no previous cases had satisfied these conditions.

A case of Reichardt's [8] is interesting because observations at autopsy were available. The case was one of optic atrophy with no perception of light. Sections showed the presence of a large number of undegenerated nerve fibers. From this finding Magitôt believed these fibers capable of mediating the light reflex but not the sensation of vision. But this interpretation seems doubtful, since the work of Léri has shown how few the persisting fibers need to be to allow the perception of light stimuli.

Hess,[9] in 1908, considered the possibility of independent mechanisms, one for the sense of vision and the other for the pupillary reaction. He believed that the theory of separate fibers for these two functions of the optic nerve had not been proved, and that its proof offered

6. Axenfeld: Lehrbuch und Atlas der Augenheilkunde, Jena, Gustav Fisher, 1923.

7. Behr: Arch. f. Ophth. **86**:468, 1913.

8. Reichardt, quoted by Wilson, S. A. K.: Modern Problems in Neurology, New York, William Wood & Company, 1928.

9. Hess: Arch. f. Ophth. **60**:380, 1908.

great difficulties. However, he did believe that separate receptors for the two functions may be present in the outer elements of the rods and cones. He was led to this conclusion by the absence of pupillary reaction to red light in night birds, which see well in red light, and also by the difference between the foveal and extrafoveal regions in their pupillary responses to light of certain wavelengths. According to his theory both types of receptors are in the same cell, giving rise to fibers that branch to the sensory and motor pathways. He stated that no pupillary reaction is present when vision is abolished, but that distinct differences in the amount of damage to individual functions can be observed.

In 1929, Hess and Groethuysen [10] showed no change in this opinion in spite of the cases of Behr and others which had been reported during the interim. In hundreds of patients with lesions of the optic nerve whom they examined, the visual discriminative acuity and the motor discriminative acuity were equally reduced, which they regarded as evidence against the theory of separate nerve fibers for each function. Hess' early theory was modified only in that the later work suggests separation of the sensory and motor part in the external geniculate body instead of in the chiasm as previously held.

To make this subject even more of a problem, cases have been reported in which the opposite conditions were found. Dunn [11] saw a patient who had glaucoma with perception of light but with total loss of direct reaction. Consensual and convergence reactions were retained. Dunn explained this condition by the damage to the retinal pigment, and believed this to be the receptor element for light reactions which goes to the ciliary ganglion by means of the short ciliary nerves. This theory regarding the pupillary reflex has not found confirmation by other observers, and seems insufficient to explain many phenomena, especially the consensual reaction.

Abelsdorff [12] reported Lohmann's case showing normal vision of the left eye and complete absence of the light reflex. The eye had astigmatism and a persistent hyaloid artery, with a pale nerve. In this case the lesion or defect of development may well have been in the retina. In Abelsdorff's own case, however, the nerve was damaged by a gunshot wound, the eye itself remaining intact. Vision of 6/10 was retained with a considerable defect in the field and complete loss of the direct pupillary reaction to light. The numerous cases of fixed pupils with retained vision from a lesion in the reflex arc have no bearing on

10. Hess and Groethuysen: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1929, vol. 12, p. 176.

11. Dunn, J.: What Constitutes the True Argyll-Robertson Pupil? Arch. Ophth. **47**:469 (Sept.) 1918.

12. Abelsdorff: Klin. Monatsbl. f. Augenh. **62**:70, 1919.

the question, as in these the lesion is known to be in the central pupillary connections above their emergence from the visual pathways.

From the report of our case and the other cases quoted, there seems to be no doubt that, aside from central lesions of the reflex arc alone and bilateral cortical blindness in which the pupillary reactions are known to be preserved, cases occur that show a marked difference between the functions of the receptor mechanism of the pupillary reaction and that of visual sensation. In the present case it seems to have been the receptors for the pupillary mechanism in the retina that were preserved intact while those for vision were left without function. The demonstration with the pupilloscope in our case that the pupillary receptors were practically intact makes it unique. The opposite discrepancy in Lohmann's case seems to have been based also on a pathologic process in the retina, and the evidence of Hess and Groethuysen is in line with a retinal location for the separate receptors. In a few cases, however, especially those of Behr and Abelsdorff, the lesion was definitely in the nerve, and these cases almost require the assumption of separate fibers in the nerve, unless one may consider that fibers capable of transmitting both kinds of impulse may be damaged so that one or the other function alone is lost.

NONSPECIFIC PROTEIN THERAPY

ADVANTAGES OF COLEY'S MIXED TOXINS *

JOSEPH LEVINE, M.D.
NEW YORK

It has been known for many years that an acute intercurrent infection has a beneficial effect on certain chronic and subacute diseases. In dementia paralytica it had often been observed that a remission developed under such circumstances, and it was this observation that led Jauregg to treat patients with this condition by inoculating them with malaria. Wagner von Jauregg [1] published his results with malarial treatment in dementia paralytica in 1918 and 1922; from then on, this method became an accepted therapeutic aid throughout the world.

In ophthalmology the same premise holds true; many intra-ocular lesions are benefited by the presence of fever. To induce a rise in temperature with leukocytosis, many foreign substances have been injected; those most commonly used are milk, diphtheria antitoxin and typhoid vaccine. There are numerous others, and apparently none is entirely satisfactory. Petersen [2] cited the following as having been used at various times in different localities: counterirritants, such as an actual cautery, moxas and blisters; blood and serums, both normal and immune, from human beings, animals and fowls; diphtheria and tetanus antitoxin; proteins, such as milk, egg albumin, casein; plant proteins and protein-split products; enzymes and tissue extracts; vaccines of all kinds; bacterial extracts and related products; colloidal metals, such as gold, silver, manganese and mercury; yeasts; irradiation by radium, x-rays and actual sunlight; and other substances such as hypertonic salt solutions, sugar solutions, distilled water, formaldehyde, turpentine, etc.

The concensus is that protein substances are the most effective, but the reason for this is not certain. It is true that leukocytosis and an increase of antibodies in the blood may often be demonstrated after protein shock, but according to Petersen this is not a constant result following an injection, and accordingly it cannot be the only reason for the recovery of the patient.

---

* Submitted for publication, Feb. 12, 1931.

1. von Jauregg, W.: Ueber die Einwirkung der Malaria auf die progressive Paralyse, Psychiat.-neurol. Wchnschr. **20**:132 and 251, 1918-1919; J. Nerv. & Ment. Dis. **55**:369, 1922.

2. Petersen, W. F.: Protein Therapy and Nonspecific Resistance, New York, The Macmillan Company, 1922.

Since Schmidt [3] and Saxl [4] first used cow's milk in 1916 to induce fever, this form of protein therapy has been the most popular, especially among ophthalmologists. According to Muskat,[5] its advantages are: Milk is a universal product; it has a constant chemical composition, and the good reaction is due to its complexity and the variety of enzymes in its cleavage products. He said that one must not use milk when there is a history of hypersensitiveness to milk or its individual proteins or in cases of myocardial involvement, alcoholism or pregnancy. Some do not use any foreign proteins for diabetic persons because of the vascular changes present in this condition. Furthermore, children with asthenia or status lymphaticus should not receive milk therapy as it might prove fatal, while scrofulous children may have fever for several weeks after an injection. These contraindications, however, are applicable to any form of foreign protein fever therapy, whether it employs milk, typhoid vaccine, serum or Coley's mixed toxins.

In 1925, Howard [6] began to use typhoid vaccine in his treatment for certain ocular lesions among the Chinese in the Peiping Union Medical College, Peiping, China. In his article, he cited many cases in which marked improvement and cure resulted. He expressed a firm belief in the efficacy of protein substances for the purpose of nonspecific fever therapy. In his experience, "no benefit resulted from an injection of vaccine that was not followed by fever," and "the degree of improvement seemed to be directly proportionate to the fever reaction." This is undoubtedly the opinion of all who have used nonspecific protein therapy.

My purpose is not to repeat what has been so admirably stated on many occasions regarding the beneficial effects of fever therapy in intraocular diseases, for instance, by Müller and Thanner,[7] Purtscher,[8]

---

3. Schmidt, R.: Ueber Proteinkörpertherapie und über parenterale Zufuhr von Milch, Med. Klin. **12**:171 (Feb. 13) 1916.

4. Saxl, P.: Ueber die Behandlung von Typhus mit Milchinjektionen, Wien. klin. Wchnschr. **29**:1043 (Aug. 17) 1916.

5. Muskat, I. I.: Milk Injections in Gonorrheal Ophthalmia, Am. J. Ophth. **2**:539 (July) 1928.

6. Howard, H. J.: Nonspecific Protein Therapy in Eye Inflammations, with Special Reference to the Use of Typhoid Vaccine, China M. J. **41**:395 and 407, 1927; The Intravenous Use of Typhoid-Paratyphoid Vaccine in Eye Diseases, Am. J. Ophth. **11**:685 (Sept.) 1928. Howard, H. J., and Mills, C. A.: Blood Changes Following Injections of Typhoid-Paratyphoid Vaccine, Proc. Soc. Exper. Biol. & Med. **24**:703, 1927.

7. Müller, L., and Thanner, C.: Heilung der Iritis und anderer Augenerkrankungen durch parenterale Eiweissinjektionen, Med. Klin. **12**:1120, 1916. Müller, L.: Prophylaktische Milchinjektionen bei Augenoperationen. Heilung der Augenblennorrhoe durch Milchinjektionen, Wien. klin. Wchnschr. **31**:933 (Aug. 22) 1918.

8. Purtscher, O.: Milchinjektionen bei Augenleiden, Ztschr. f. Augenh. **43**: 100 (Jan.) 1920.

Lindig,[9] Gaston,[10] Key,[11] Mason,[12] Uddgren,[13] Allen,[14] Igersheimer,[15] Fraser and Duncan,[16] and E. F. Müller.[17] I believe that all oculists are agreed on this point, but many would like to have at their command some substance that does not have the disadvantages of milk and of typhoid vaccine. To obtain any effects from milk from 10 to 20 cc. is used; for this injection the gluteal region is necessary. Furthermore, the milk must be boiled by the oculist or his assistant and then a period of time allowed for cooling before the injection is given. All this takes time and causes annoyance to the patient and physician. The intravenous injection of typhoid vaccine requires hospitalization or must be made at the patient's home. For this reason, it has not become so popular as injections of milk.

When the advantages of a prepared, standardized substance already put up in rubber-capped vials, similar to the insulin containers, are combined with minute dosage (3 minims), allowing of injection into the muscular tissues of the arm, this form of therapy may be used to a greater extent and with better results. Such a substance is the bacterial vaccine known as Coley's mixed toxin.[18] This consists of "a mixture of the toxins and derivatives from killed cultures of *Streptococcus erysipelatis* and *Bacillus prodigiosus* which are grown separately, then mixed, and finally diluted to a definite strength as determined by the percentage of protein contained."

Mason used bacterial antigen because he thought that this "product would give the good results of a foreign protein without severe shock following its injection." According to the company that prepares this substance, immunogens are not recommended as nonspecific protein agents; their protein content is probably too low to be of any value in

---

9. Lindig, P.: Das Kasein als Heilmittel. Ein Beitrag zur Frage nach dem Wesen und dem wirksamen Faktor der Milchtherapie, München. med. Wchnschr. **66**:921 (Aug. 15) 1919.

10. Gaston, I. E.: Milk Injections in Ophthalmic Cases, Am. J. Ophth. **9**:111 (Jan.) 1926.

11. Key, B. W.: Protein Injection in Severe Ocular Infections, Arch. Ophth. **51**:471 (Sept.) 1922.

12. Mason, R. E.: Bacterial Antigen in Uveitis, Am. J. Ophth. **11**:702 (Sept.) 1929.

13. Uddgren, G.: Milchinjektionen in der Ophthalmologie, Stockholm, 1918.

14. Allen, T. D.: Typhoid Vaccine in Ophthalmology, Tr. Sect. Ophth., A. M. A., 1925, p. 135.

15. Igersheimer, J.: Specifische und unspecifische Therapie in der Augenheilkunde, Therap. Halbmonatsch. **35**:104 (Feb. 15) 1921.

16. Fraser, A. R., and Duncan, A. G. B.: The Treatment of Chronic Gonorrheal Rheumatism by Vaccines Given Intravenously, Lancet **1**:248, 1920.

17. Müller, E. F.: Die Bedeutung des Kaseins in der Milchtherapie, München. med. Wchnschr. **66**:1233 (Oct. 14) 1919.

18. Prepared by Parke, Davis & Company.

this respect. They are primarily and solely specific. In the preparation of immunogen, live organisms are extracted for a short time with physiologic solution of sodium chloride immediately on being taken from the culture medium on which they have grown. This rapid extraction prevents the formation of bacterial autolysates which are known to be more or less toxic. Being merely washings of the bacteria and not the bacteria themselves or the culture medium in which they have developed, immunogens contain little protein and are free from toxin. Nitrogen determinations show, for the same number of organisms represented, that the total nitrogen and total estimated protein is about one-tenth that of any other antigenic substance used for similar purposes, e. g., bacterial vaccines such as typhoid vaccine or Coley's mixed toxins. I have used the latter for exactly this reason: It contains a high percentage of nonspecific proteins in a concentrated form.

The material is red and is put up in 1 cc. and 15 cc. rubber-capped bulbs. These are dated because the material is slightly unstable and is not to be used after the date has expired. The dosage for each injection is 3 minims for an adult and proportionately less for children. Deep intramuscular injections are given into the arm with the ordinary tuberculin syringe and a fine hypodermic needle about 1 inch (2.5 cm.) long. The 1 cc. containers are advisable for office use and the 15 cc. containers for hospitals. I have given approximately 100 such injections to patients at my office and the Manhattan Eye, Ear and Throat and Mount Sinai Hospitals. In only 2 cases was it necessary to increase the dose to 4 minims to obtain a suitable reaction. This occurs in from four to five hours after the injection, which allows the patient time to reach his home before the onset of a chill, which lasts from fifteen minutes to one-half hour; this is followed by an elevation of temperature ranging from 101 to 103 F. (rectal) and lasting from twelve to twenty-four hours. Occasionally there is profuse sweating followed by weakness; there is no headache or vomiting. Redness may occur at the site of injection, at times accompanied by pain and swelling of the arm, but this is quickly and easily relieved by the application of cold compresses.

Coley's mixed toxins have been used in cases of acute iritis, uveitis with keratitis punctata, corneal abscess, corneal ulcer, vitreous opacities with no discernible uveal lesion and postoperative iridocyclitis, with uniformly good results because of the fever resulting from the fluid. A recital of case histories would be only a repetition of what is well known, namely, that nonspecific protein fever therapy has a beneficial effect on certain intra-ocular conditions such as those enumerated. This is written with the purpose of bringing to the attention of ophthalmologists a useful protein that is easily administered and of almost negligible cost (each injection costs approximately 5 cents) and that gives good results.

HYALOID REMNANTS AS A SOURCE OF SCOTOMAS*

MORIE FREDERICK WEYMANN, M.D.
LOS ANGELES

The existence of rests of the hyaloid artery and its branches had been demonstrated in the eyes of many persons with the ophthalmoscope before the advent of the slit-lamp, but it remained for Vogt to ascertain by biomicroscopy that some remnant of the hyaloid artery could be found in every one.

These hyaloid remains vary greatly in size and shape, and for their picturization one is referred to the atlases of Vogt [1] and Meesmann.[2] Ordinarily, a wavy or spiral white or gray strand arises from the posterior part of the capsule of the lens, slightly nasalward from its center. This strand then extends 1 or 2 mm. or more backward into the vitreous and ends freely, at times with a little bulbous thickening at its extremity. On movement of the eyeball this free end acquires a wavy motion which is probably caused by the motion of the vitreous, but when the strand again comes to rest it always has the same position with reference to the lens. Thus it seems to be in some anatomic connection with the fibril structure of the vitreous, and is not entirely freely floating. At times the strand is branched, or it may have one or more thickenings of a nodular form in its course.

As the attachment to the lens capsule is somewhat to the nasal side of the optic axis, the opacity produced by the small button-like thickening at this point does not interfere with vision and is not subjectively noticeable. But if the strand itself is long enough to extend out into the optic axis of the eye, and especially if its end shows thickening into a bulb, it is reasonable to suppose that the shadow thus produced would be noticeable under suitable conditions of light.

Concerning this point Meesman wrote:

> Knowledge of these physiologic rests also has its clinical value. They may be mistaken for pathologic lens or vitreous changes. Besides that, they occasionally give rise to a positive scotoma. Extension of the unattached ends into the region of the posterior pole and thereby into the optic axis is not rare, at least in the larger vessel rests. Under particular optical conditions, for example, in regarding a bright surface, a positive scotoma can be produced. Intelligent patients occasionally draw the form of the scotoma directly corresponding with the hyaloid rest visible by means of the slit lamp.

* Submitted for publication, Jan. 26, 1931.

1. Vogt, A.: Atlas der Spaltlampenmikroskopie des lebenden Auges, Berlin, Julius Springer, 1921.

2. Meesmann, A.: Die Mikroskopie des lebenden Auges an der Gullstrandschen Spaltlampe mit Atlas typisher Befunde, Berlin, Urban & Schwarzenberg, 1927.

I shall now report two cases in which a knowledge of these facts made both me and the patients considerably more comfortable.

REPORT OF CASES

CASE 1.—V. M., aged 33, an art student of neurotic tendencies, complained of seeing a definite spot before each eye, an outline of which he was able to sketch. The spot always occupied the same relative position in the visual field, close to its center, and moved in accordance with the movements of the eye. Biomicroscopic examination disclosed a hyaloid rest extending over into the optic axis of each eye. When the narrow beam from the slit-lamp was played over these rests, the patient was able to recognize the spots of which he complained. After an explanation of the cause of the spots, the patient's fear of approaching blindness was relieved.

CASE 2.—P. S., aged 37, also with neurotic tendencies, had noticed a figure or pattern before each eye for two years. This had come to worry him a great deal and he had even received antisyphilitic treatment on an empiric basis. The patterns seen were in the central portion of the field and moved as the eyes moved. They did not float. The spot before the left eye was most noticeable. Biomicroscopy demonstrated distinct hyaloid remains extending into the optic axis. The rest in the left eye was larger and showed branching. The narrow beam played over these rests also produced the scotomas described by the patient so that he could recognize them. No pathologic changes were present in either eye. Again an explanation sufficed to set the patient's mind at rest.

In considering the two patients one first notes that both of them were of a neurotic temperament. These are the persons who are prone to notice other entoptic phenomena and to be disturbed by them. Doubtless many stolid persons have hyaloid rests extending into the optic axis and never notice the scotomas produced.

One characteristic of the scotomas described, which were produced by hyaloid rests, is their central location in the field. Another is that their relative position in the field always remains the same, even on movement of the eyes, and that they do not "float" as do the shadows produced by floating strands in a degenerated vitreous.

Finally, the recogition by the patient of the scotoma when the narrow beam is passed over the offending hyaloid rest verifies the diagnosis. It is most useful to have this accurate means of explaining a symptom that may be of the utmost annoyance to both the patient and the oculist.

SUMMARY

1. It is possible for rests of the hyaloid artery to produce positive scotomas under certain conditions.

2. Such scotomas are located in the central portion of the field, do not float and move in correspondence with movements of the eyes.

3. By biomicroscopy the offending hyaloid rest may be located, and the scotoma may be produced by playing the narrow beam over the area occupied by the rest. For this examination the pupil should be fully dilated.

2007 Wilshire Boulevard.

CERTAIN PATHOLOGIC CONDITIONS ABOUT THE CHIASM

WITH SPECIAL REFERENCE TO PITUITARY ADENOMAS *

T. B. HOLLOWAY, M.D.
PHILADELPHIA

In approaching a study of certain lesions that may develop at the base of the skull in the vicinity of the chiasm, it seems appropriate to refer to certain anatomic conditions that many influence, to some extent, certain signs or symptoms that are prone to occur.

The circle of Willis, situated in the interpeduncular cistern, forms a complete circular anastomosis in 93 per cent of the cases; in Stopford's [1] series of one hundred and five specimens, the remaining 7 per cent concerned the posterior communicating artery. In early intrauterine life this artery represents the origin of the posterior cerebral from the internal carotid artery, but later, after the posterior cerebral artery has formed its anastomosis with the basilar artery, the posterior communicating artery becomes of less importance. Its ultimate size and importance vary with the efficiency of the anastomosis referred to. In one of Stopford's cases it was absent. For a number of years it has been realized that the anterior cerebral arteries are not always constant in their course, and, as pointed out by Sachs, Bartels, Cushing, de Schweinitz and Holloway, Hirsch, Siegrist and others, these structures are capable of constricting portions of the underlying visual pathway. De Schweinitz and Schaeffer,[2] in their excellent study of this question, showed a number of variations in the course of the anterior cerebral arteries, indicating how a constriction might influence the visual fields. Behr, at autopsy on a patient with craniostenosis, found that the internal carotid artery encroached on the lower part of the optic foramen, producing a stenosis of the foramen with consequent lymph stasis.

While choked disk is not the most frequent manifestation of the disk in association with the lesions under discussion, it occurs in a definite number of cases. Although most observers have accepted the mechanical theory of choked disk, I have always believed that another

* Submitted for publication, March 28, 1931.
* Read before the Pittsburgh Academy of Medicine, March 10, 1931.
* From the Department of Neurosurgery and the Department of Ophthalmology, Hospital of the University of Pennsylvania.

1. Stopford: J. Anat. & Physiol. **50**:131, 1915-1916.
2. de Schweinitz and Schaeffer: Tr. Ophth. Soc. U. Kingdom **43**:12, 1923.

factor was frequently present, so that the cause of the choking might be attributed to the mechanical theory plus x, the latter factor doubtless constituting a variable quantity, but one which might influence the time of onset or the intensity, duration or absence of choking. Certain of these x factors are evident in the position of the growths mentioned. Such a factor was brought forward recently by Swift [3] in citing what he believed to be the influence of the unequal development of the venous sinuses on the production of choking, which he illustrated in the reports of three cases. He further referred to the observations of Streeter, who found that the longitudinal sinus and the two transverse sinuses showed a greater development on the right side in 89 per cent of all cases. My associate, Dr. W. E. Fry,[4] in a recent study of serial sections of thirty-six nerves showing choking, confirmed the previous work of Paton and Holmes concerning the variable intraneural and intervaginal course of the central vessels of the nerve. In many of the cases the vein had a long course in the subpial or intervaginal space.

Zander, Wallis and others who made special studies of the relationship of the chiasm to other structures pointed out that it was frequently placed on one side or the other of the midline. De Schweinitz and Schaeffer, in their studies of the chiasm, found that in 79 per cent of cases the anterior or the greater part had a relation to the diaphragm of the sella; in 12 per cent it was directly over it; in 5 per cent the dorsal part of the chiasm was in relation to it, while in 4 per cent the entire chiasm was behind the diaphragm. But what is just as important, probably more so, is the fact that the distance between the base of the chiasm and the diaphragma sellae is variable, being at times as great as 1 cm. This factor would be of considerable importance in its relation to these growths, especially the sellar growths. De Schweinitz and Schaeffer pointed out that this variability was dependent on either osseous or brain-stem factors, or both.

In 1920, Traquair [5] cited the history of a case of pituitary tumor in which autopsy disclosed a separate anterior commissure in the form of a separate band of nerve tissue passing between the inner sides of the two optic nerves across the front of the chiasm, analogous to the commissure of Hannover. The sections were examined by Dawson, who found that the commissure consisted of myelinated nerve fibers surrounded by pia arachnoid and that the fibers were continuous with the inner bundle of fibers of the optic nerve. Their course was posterior

3. Swift, G. W.: Transverse Sinus and Its Relation to Choked Disk, Tr. Sect. Ophth., A. M. A., 1929, p. 213.

4. Fry, W. E.: Variations in Intraneural Course of Central Vein of Retina, Arch. Ophth. **4**:180 (Aug.) 1930.

5. Traquair: Tr. Ophth. Soc. U. Kingdom **40**:198, 1920.

and not anterior. Traquair referred to the observations of Sneed,[6] who found at autopsy a congenital division of the right optic nerve and who referred to similar cases described by Ganser, Schlagenhaufer and Fuchs. In Sneed's case the two divisions were separated by sheaths of connective tissue. The tracts were normal except at the chiasm, where slight projections of the perineurium could be seen invading the right tract. In the other three cases referred to, the isolated bundle followed the course of the uncrossed fibers.

I have referred to the influence that the osseous tissue may have in determining the distance between the chiasm and the diaphragma sellae; this pertains particularly to the elevation of the anterior fossa and the depth of the pituitary fossa. An examination of the base of a skull in the possession of Dr. H. K. Pancoast revealed what appeared to be a double optic foramen. The upper aperture was the real foramen. The lower was formed by ridges of bone extending from what should be the tips of the anterior clinoid processes to the olivary eminence. In addition to this, a bony ridge connected the anterior and the posterior clinoids on each side. This was probably the so-called middle clinoid process. A double optic foramen is rare and has been attributed to ossification of the fibrous membrane separating the artery and vein. This condition was recently found in a patient with retrobulbar neuritis.

At the present time all of the pituitary lesions on file in the neurosurgical service are undergoing review and reclassification. From the large group of adenomas sixty verified cases have been isolated and thirty-one of these selected for review. This group of cases was taken because all of the perimetric examinations were made under identical conditions as to examiner, illumination, test objects and other details pertinent to accepted perimetric methods. A review of pituitary adenomas will be found in an article by Dott and Bailey.[7]

SYMPTOMS

All those who have had the opportunity of coming in contact with a considerable number of patients with tumors about the chiasm have noted how frequently these patients have been seen at earlier periods by one or more ophthalmologists. Considering the fact that the two earliest and consistently outstanding symptoms are headache and failing vision, this is a natural consequence. The failure of the ophthalmologist to recognize the condition in the early stages is frequently excusable, particularly in cases in which these symptoms existed before and were relieved by glasses, in cases in which there is standard vision but the

6. Snead, C. M.: Arch. Ophth. **44**:418, 1915.
7. Dott and Bailey: Brit. J. Surg. **13**:314, 1925.

examiner is ignorant of what may be normal for that particular individual, or in those instances in which there is misty or foggy vision but the patient can still read the standard vision line. Still further, ignorance on the part of the layman, and for that matter some physicians, as to what can be accomplished by glasses, is another factor. The patient consults the physician for a pair of glasses in order to see better; if he fails to do so, despite the instructions that he has received, he will probably consult another physician and repeat his former experience. If these ideas prevail, not infrequently cooperation as to the past medical history is vastly different from that encountered later when the patient is seen by the neurologic surgeon. Here as elsewhere in medicine one is treating a patient and not an organ, but it is difficult to convince a person who believes that he needs a pair of glasses that neurologic,

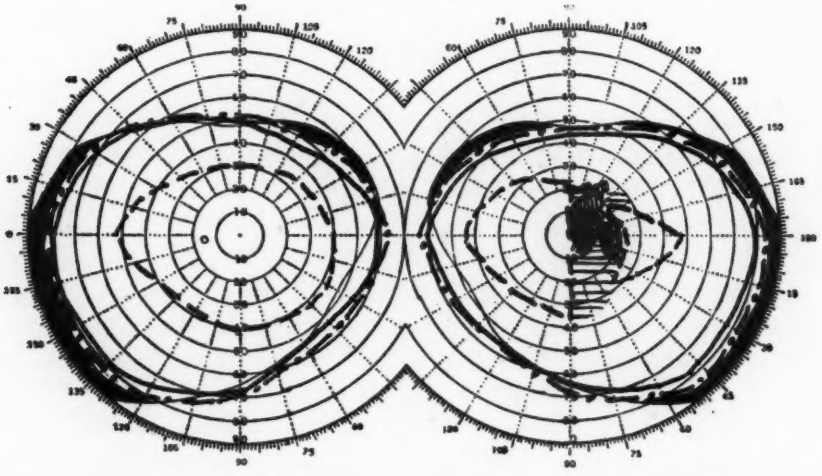

Chart 1.—Splitting of temporal color field by vertical scotomatous area. In this and the accompanying charts, dash line shows field for red (1 degree); solid line, field for white (1 degree), and dot and dash line, field for white (2 degrees); vertical hatched area indicates scotoma for white (1 degree); horizontal hatched area, scotoma for red (1 degree), and black area, absolute scotoma.

roentgen, rhinologic and laboratory examinations are necessary. The average ophthalmologist is contented with a history that is much too brief, and he permits himself to be deprived of data that would be desirable and often necessary to an adequate study of the case. Under ordinary conditions there is no excuse for the physician who fails to examine adequately the patient whose headache and failing vision have been treated unsuccessfully by another competent physician. At best, most clinical conditions are difficult to diagnose in their incipiency; they become much simplified in the later stages, especially on the autopsy table.

These comments have been made because many of these patients with chiasmal symptoms come to the surgeon when they have advanced to the stage in which the vision of one or both eyes is markedly reduced or even abolished, the disks are atrophic and the visual fields show marked defects. The surgeon can no more regenerate atrophic nerve fibers with a knife than he can with epsom salts, but with the former in a favorable case, in which definite atrophy has not developed or in which it exists but has not progressed too far, he can relieve certain blocks of the visual pathway about the chiasm that produce a train of symptoms in which failing vision usually occurs early and is conspicuous. Still further, it may influence the trend of associated pituitary disorders. Frazier and Grant,[8] writing in 1925 concerning primary intrasellar lesions in one hundred cases, stated that the interval between the time

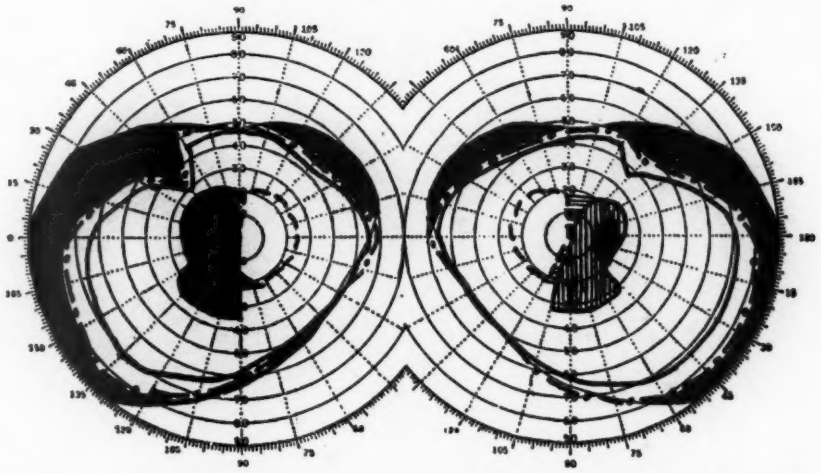

Chart 2.—Early indentation of superior temporal quadrants and large bitemporal scotomas.

of onset of symptoms and the patient's entry into the hospital varied from one to more than twelve years, in half of the cases within three years.

Many writers have discussed in detail the headache associated with pituitary disease, especially de Schweinitz, and more recently Beckman and Kubie.[9] The last mentioned observers stated that the pain is more apt to be localized in the intrasellar growth than in tumors of the stalk, in which increased intracranial pressure is apt to occur. In their twenty cases of adenoma the pain was frontal, above, in or behind the eyes, in sixteen instances, or 80 per cent. In sixteen cases it began simul-

8. Frazier, C. H., and Grant, F. C.: Pituitary Disorder, J. A. M. A. **85**:1103 (Oct. 10) 1925.

9. Beckman and Kubie: Brain **52**:127, 1929.

taneously with, or later than, the onset of the visual disturbance. In Frazier and Grant's series it was more varied, but in the majority of the cases analyzed it was frontal. It preceded other symptoms in 27 per cent. The same statement as to frontal predominance is true in the present series; in one instance it was retrobulbar and in another "between the eyes," In this series, when such data was available, it preceded the visual disturbance in 33 per cent. When precedence was evident or specified, visual disturbance preceded the onset of headache in 66 per cent of the cases. The visual manifestations at times have been but the faintest blurring or haziness, but not infrequently there is an appreciable loss of vision before the condition is detected. As a rule, central vision tends to decrease gradually, although it may be unfavorably influenced early by the development of scotomas. At other times, with-

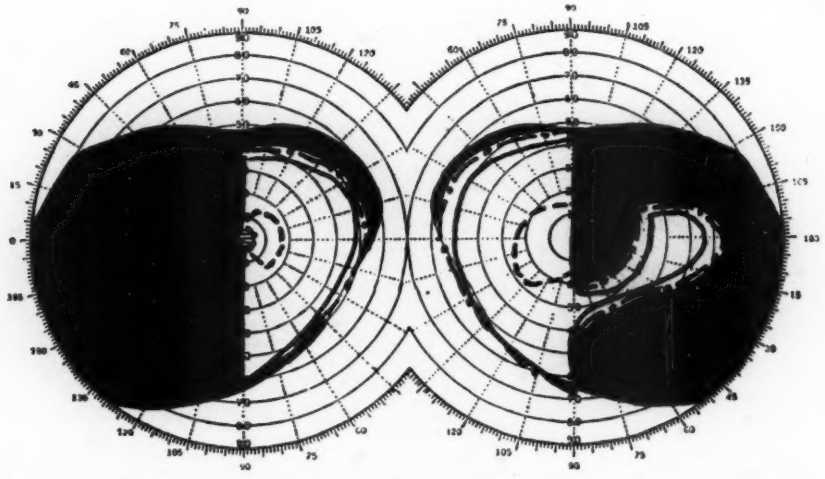

Chart 3.—Bitemporal hemianopia. Further constriction in the temporal field of the right eye would result in a retained field.

out definite assignable cause, the vision may show some temporary improvement, but the tendency is to become progressively worse as the fields decrease; in certain cases the loss may occur abruptly. It is conceivable that a spontaneous decompression might result in temporary improvement. Certain of the patients in the present series complained of poor ocular tolerance; another stated that he "felt he was looking through opera glasses." One complained of missing words when reading, and still another "would start the next sentence before finishing the one he was reading." Lacrimation and photophobia were also noted.

There is a sharp contrast in the average age of the patients in the series recorded by Deery [10] and that for the present series in which

10. Deery: J. Nerv. & Ment. Dis. **71**:383, 1930.

the average age was 34. In his analysis of fifty-four cases of adenoma the average age was 58 years. On admission, forty-nine patients had poor vision in one or both eyes, twenty-eight of them retaining fair vision in one eye, but in ten (18.5 per cent) it was poor in both eyes.

The essential change in the disk in cases of adenoma is primary optic atrophy; in this series, it was present in twenty-four cases, or 77.4 per cent. In two instances, or 6.5 per cent, there was early choking, the swelling in each case amounting to 1.5 diopters. Five patients, or 16.1 per cent, had normal disks associated with impaired vision in one or both eyes; in one case vision was as low as 6/15 in the right eye and 6/45 in the left. Among the twenty-four cases showing atrophy, there was a yellowish tint in ten, or 41.6 per cent, while a waxy appearance, with or without a yellowish color, was described in seven instances, or 29.1

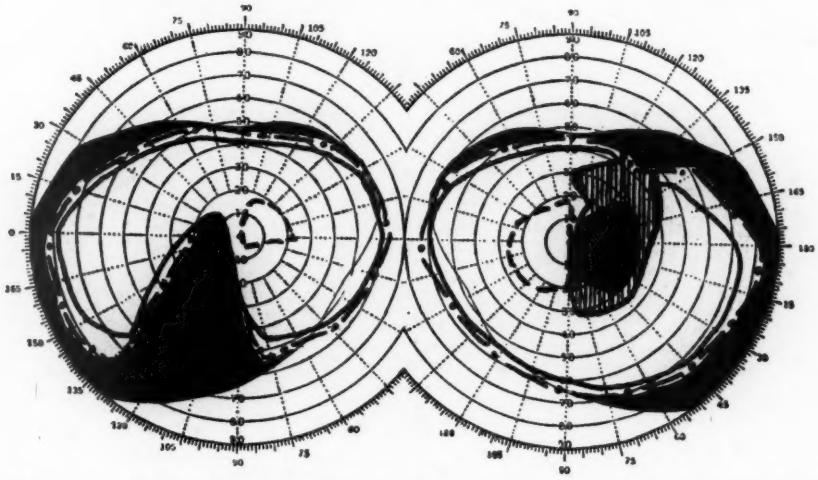

Chart 4.—Superior temporal quadrant defect in the right eye with an inferior temporal quadrant defect in the left. Black area indicates absolute scotoma for white (2 degrees).

per cent. In Beckman and Kubie's series of twenty cases, eighteen patients had optic atrophy and two had normal disks, but in no instance was there a papilledema. Deery referred to forty-seven cases of primary optic atrophy, in four of which choking was present, while three manifested a postpapillitic atrophy. Combining these two series with the present one gives one hundred and five verified cases showing the following results: primary optic atrophy in eighty-nine cases, or 84.7 per cent; papilledema in nine, or 8.5 per cent, and normal disks in seven, or 6.6 per cent.

In this country the general trend of the fields in pituitary tumors was accurately determined by Cushing and Walker, and their observations have been substantiated repeatedly by others. Usually the changes

begin by indentations in the superior temporal quadrants of each eye, proceeding downward in the temporal fields and then upward in the nasal fields. There has been some variation in opinion as to whether the inferior or the superior nasal field is the last to disappear. My own experience is in accord with that of Traquair, for in a definite majority of the cases showing terminal defects, the greater part or all of the remaining field has been in the superior nasal quadrant. An unusual case in the present series showed a left homonymous hemianopia and a terminal field in the right inferior quadrant of the right eye; the change in the field was unusually abrupt, occurring within a week. Like bitemporal hemianopia, homonymous hemianopia may begin by slight notching. This defect, as will be shown later, is seen in a definite number of cases.

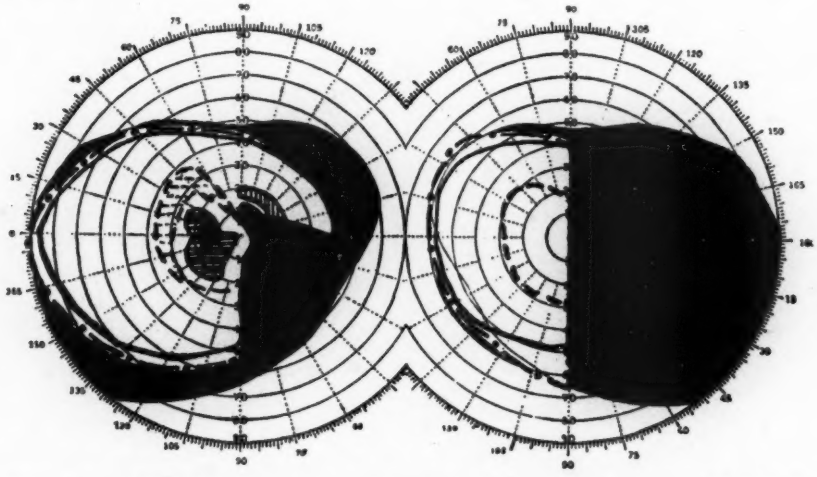

Chart 5.—Right homonymous hemianopia that probably began in the lower fields. Scotomas in the left field, particularly in temporal field. Dotted area indicates indistinct vision for red (1 degree).

At times a field is encountered in which the defects begin in the lower temporal quadrants; in one instance in the present series the preoperative field showed a defect in the upper temporal quadrant of the right eye, with a corresponding manifestation in the lower temporal field of the left eye; however, this is a most unusual observation. While bizarre effects are noted in cases of adenoma they are not as frequent as in certain other types of tumors affecting the chiasm. As a rule, in this group the fields of the two eyes do not show as great a difference in the extent of involvement as is seen in some other types of growths. In certain instances, however, well defined changes will be noted in one eye and the field of the other may be normal. In at least two such instances in the present series the growth was found entirely or chiefly

involving the optic nerve on the side of the defective field. Just as in a case of Frazier's,[11] a patient in the present series showed a button-like nodule of the growth directly affecting one optic nerve. My observations also confirmed those of others as to the usual presence of an irregular hemianopia rather than a straight vertical dividing line between the existing and the obliterated fields.

In at least two cases, grooving of the optic nerve was noted, in one instance doubtless vascular and in the other probably due to the dural edge or margin of the optic foramen. The size of the growth influences the extent of the distortion and flattening of the visual structures, and in certain cases in which traction and pressure on the visual structures are considerable, with an unknown neurovascular distribution, it is often impossible, or at least inadvisable, to depict accurately the changes

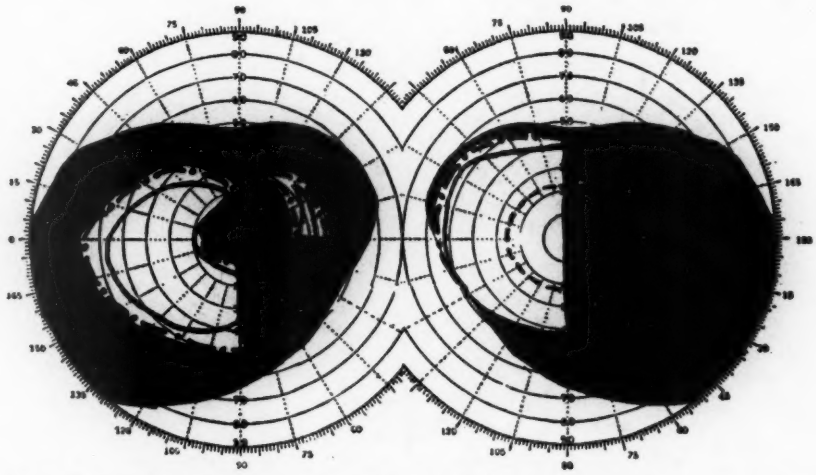

Chart 6.—Right homonymous hemianopia with retained field in superior nasal quadrant of the left eye.

in the fields that may result from the gross picture presented. Adequate knowledge concerning the exact distribution of the visual fibers is still lacking, and the irregularities of vascular distribution are well known.

Of the three chief factors offered in explanation of the defects, in the fields—traction, pressure and toxins—I am of the opinion that pressure is the most important and most frequent. In this I include, as Traquair insisted, its influence on vascular changes and consequent nutrition. I do not believe traction can be wholly excluded; as an associated factor and when rigid structures are encountered, it should have a distinct influence. Dogmatic assertions are not advisable con-

11. Frazier, C. H.: A Series of Pituitary Pictures, Arch. Neurol. & Psychiat. **23**:656 (April) 1930.

cerning a theory on any subject in which the development of knowledge and progress have been as rapid as in pituitary disease. While de Schweinitz and Traquair have discussed the possibilities of toxins, their comments have been chiefly suggestive. Despite the lack of knowledge concerning toxins, I have always regarded them as a possible factor in certain instances in the production or accentuation of scotomas. While these toxins might not have any affect on healthy tissue, it seems to me that they might have a decided influence on tissues much impaired by faulty nutrition. While in no sense confirming this suggestion, it is interesting to note the comments of Sargent [12] that he always seals a puncture in a tumor or cyst because the escape of "toxic material" into the cerebrospinal fluid may be followed by symptoms of toxemia, and that this is particularly true of cysts containing cholesterol.

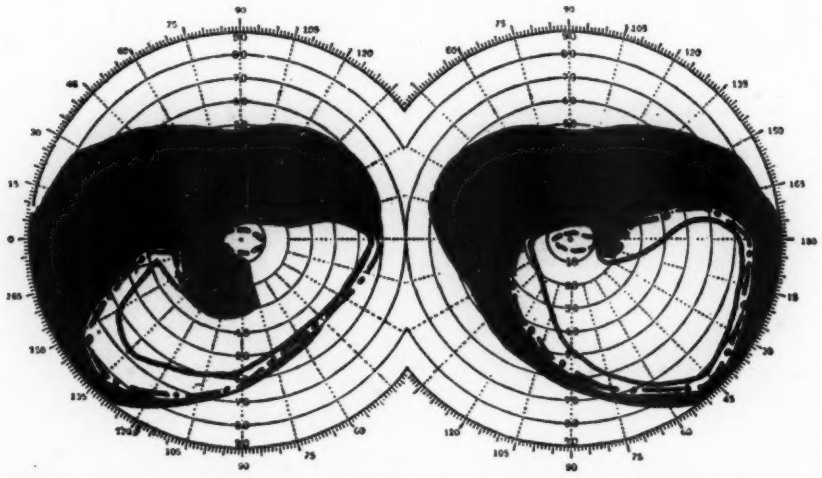

Chart 7.—Altitudinal hemianopia with indentations through blind spots.

In the present series of adenomas a bitemporal hemianopia was present in seventeen cases, or 54.8 per cent. In four instances, 12.9 per cent, there was a temporal loss of vision in one eye, while the other eye was normal in two cases and blind in the others. Whether these cases would have developed into, or whether they had been cases of bitemporal or homonymous hemianopia, it is impossible to say. Five patients, or 16.1 per cent, had homonymous hemianopia. In two, or 6.4 per cent, an altitudinal hemianopia was present, inferior in one and superior in the other. This I believe to be an incidence above what might be expected, and it is not maintained in the same proportion when a larger group is considered. Two patients (6.4 per cent) had concentric contraction of the fields. In one instance, the only

12. Sargent: Brit. J. Surg. **11**:521, 1923-1924.

change in the fields was a marked temporal defect in the color field of the right eye, as tested on the Ferree-Rand perimeter. In no instance were there normal fields for both eyes. Well defined circumscribed scotomas was present in five instances, or 16.1 per cent.

Beckman and Kubie found a bitemporal defect in fifteen fields, in one case altitudinal hemanopia of inferior type was observed, while one patient had normal fields and in another the fields were of uncertain type. No instances of homonymous hemianopia or concentrically contracted fields were observed. In Deery's statistics there were forty-five instances of the bitemporal type, five were homonymous and in four there were no defects. These statistics combined with those of the present series provide one hundred and three available verified cases of adenoma in which the hemianopia was bitemporal in seventy-seven, or 74.8 per cent, homonymous in eleven, or 10.7 per cent, and altitudinal and concentrically contracted in two each, or 1.9 per cent. In five instances, or 4.9 per cent, the fields were normal. In six cases, or 5.8 per cent, the fields were classified as uncertain; these include the one case in the Beckman and Kubie series and the four in the present series in which a temporal loss was present in one eye while the other eye was normal or blind.

While involvement of the ocular nerves is at times associated with pituitary tumors, it is more prone to occur in certain other tumors influencing the chiasm than in adenomas. In the present series there was involvement of the third nerve in one instance and of the sixth nerve in another. A past history of diplopia was elicited in three other patients. In the statistics of Beckman and Kubie [13] there were six instances in which diplopia was present without accompanying weakness of the extra-ocular muscles. In a subsequent contribution these same authors offered a clever and ingenious explanation for the type of diplopia encountered in cases in which no involvement of the muscles can be demonstrated. After referring to the use of corresponding points of the retina in the maintenance of binocular single vision, they briefly discussed miners' nystagmus. Miners work with extremely low illumination, and in the dark-adapted eye the perimacular region has better visual acuity than the macula, but in the former area fatigue rapidly develops and there is no one point at which the vision is greater than at another point. As a consequence, in eyes without anomalies of the muscles or fields, homologous points are utilized, and while the eyes may roll, there is no diplopia. Beckman and Kubie expressed the belief that this is analogous to what happens in these patients with heteronymous defects in the fields when macular vision is defective. To compensate for the defects in the fields and central vision, despite the fact that corresponding points are not available, the extra-ocular muscles attempt to bring into use portions of the retina which previously had been unassociated, and

13. Beckman and Kubie: Brain **52**:317, 1929.

a consequence diplopia develops. While almost any theory or new thought is open to various adverse suggestions, they submit data concerning a number of cases; one case particularly appears convincing. The observation is a splendid one and should be thoroughly investigated.

Exophthalmos was not observed in any of the cases in this series, and nystagmus was observed but once.

CONCLUSIONS

In cases of adenoma depreciation of vision is usually the first symptom noted; it is sometimes preceded by headache, usually early in the disease. The most frequent manifestation of the disk is a primary optic atrophy (in 84.7 per cent), and this is observed about ten times as frequently as is choked disk. The atrophy assumes a yellowish tint in about 42 per cent of the cases. In about 29 per cent the disk may present a waxy appearance. The hemianopia produced tends to be irregular rather than having a vertical line that sharply differentiates the obliterated from the remaining field. A bitemporal hemianopia (74.8 per cent) occurs about seven times as frequently as a homonymous defect. Concentric contraction and altitudinal defects occur in about 2 per cent of the cases.

Involvement of the extra-ocular muscles is at times noted and it is possible, as suggested by Beckman and Kubie, that diplopia may occur independent of any true muscular palsy.

LYMPHORRHAGIA RETINAE TRAUMATICA*

ANDREW RADOS, M.D.
NEWARK, N. J.

Purtscher[1] observed and described a rather peculiar lesion of the retina following serious concussions; he named it angiopathia retinae traumatica or lymphorrhagia retinae. Through his work attention has been focused on the subject. There are reports of similar observations, especially in the German literature; however, these observations are not numerous. In 1921, Vogt and Knüsel[2] mentioned only ten cases among thirteen eyes examined.

In Purtscher's first case the condition was caused when the patient fell from a roof; loss of consciousness for six days resulted. The eyegrounds showed rather interesting changes. The margins of the disk were sharp, and the disk was somewhat pale. In the macular region a delicate irregularity of the surface was noted; in the retina of both eyes, along the course of the larger vessels, there were numerous bright, white, shiny plaques. The spots varied in size, from half the size of the disk to confluent and smaller patches. The latter gave the impression that they had been formed through the aggregation of the minute spots, partially covering the retinal blood vessels; therefore, the location of the spots must necessarily be the inner layers of the retina. Between the spots described there were small stripe-shaped hemorrhages with dilated and tortuous vessels.

The patient in Purtscher's second case also gave a history of a fall on the head from a height of 12 feet (365.8 cm.), resulting in stupor of short duration. The patient was examined for the first time nineteen days after the accident, and changes of a nature similar to those in the first case were revealed between the macula and the disk, extending into the periphery. The changes were present along the veins; the arteries were not involved. Preretinal bleeding was present in the form of stripes; as many as twenty-nine oval or oblong spots were counted, which varied in size from one to one and one-half disks. The retinal veins were partially covered by the spots, and there were marked interrelations. The margins of the spots were indistinct being broken up into minute points and stripes; they were somewhat shiny and silvery, with a bluish tint. The spots seemed to have a predilection for the macular area. The left eye of the patient showed twenty-three spots of similar nature. Both

* Submitted for publication, Feb. 21, 1931.

1. Purtscher: Angiopathia retinae traumatica: Lymphorragien des Augengrundes, Arch. f. Ophth. **82**:347, 1912.

2. Vogt and Knüsel: Die Purtschersche Fernschaedigung der Netzhaut durch Schaedeltrauma, Klin. Monatsbl. f. Augenh. **67**:513, 1921.

cases were characterized by a marked tendency toward a rapid disappearance of the condition, the solitary plaques breaking up into minute shiny stripes and spots and disappearing completely within four months, leaving only a discoloration of the disk. Purtscher not only observed these changes, but he realized that they presented a separate group of pathologic retinal changes due to indirect traumatic lesions. He thought that the cases of Koerber [3] and Liebrecht [4] in the earlier literature belonged to this group, in spite of the fact that Liebrecht himself indicated a different opinion in a later paper referring to his case. Study of the earlier literature, however, proves that even in the most variable group of posttraumatic retinal changes a separate and distinct group can easily be isolated according to the description of Purtscher. Jacobi's [5] was mentioned first; a piece of timber fell on the patient's head, causing bleeding from the mouth and ears. Autopsy showed a fractured base around the sella turcica. Eleven days after the accident ophthalmoscopy proved the presence of white and yellowish-white spots around the disk, with small coalescing hemorrhages. In Koerber's case, six days after fracture of the skull, there were large white spots with sharp margins around the disk, which were partly confluent, following the course of the larger vessels and covering them accidentally. In about three weeks a marked diminution of the white spots occurred. In place of the previously large plaques there were only small silvery granules, which gradually and slowly merged into the normal surroundings. During the same period, the smaller spots disappeared.

In the case reported by Gonin [6] compression caused a fracture of the skull, jaw and bones of the forehead. Fourteen days later, ten white spots were found distributed along the veins and between the disk and the macula; the spots varied in size from one-fourth to one-half that of the disk. Numerous small punctate and stripe-shaped bleedings were noted, and two large retinal hemorrhages were present. Repair took place rather rapidly, only one white spot remaining after three months. In Best's [7] case, four days following injury, the vision was greatly reduced, and there were small paracentral scotomas directed upward and downward. Along the superior, inferior and temporal vessels white spots were sharply outlined in the macular area; the disk and macula were uninvolved. There was only one small retinal bleeding,

3. Koerber: Centralbl. f. prakt. Augenh., 1910.

4. Liebrecht: München. med. Wchnschr., 1903; Arch. f. Ophth., 1906, vol. 55; ibid. **83**:525, 1912.

5. Jacobi: Ophthalmologische Befunde, Arch. f. Ophth. **14**:147, 1868.

6. Gonin: Altérations rétiniennes consécutives à une fracture du crâne, Ann. d'ocul. **147**:98, 1912.

7. Best: Commotio retinae als Fernwirkung, Klin. Monatsbl. f. Augenh. **63**: 578, 1919.

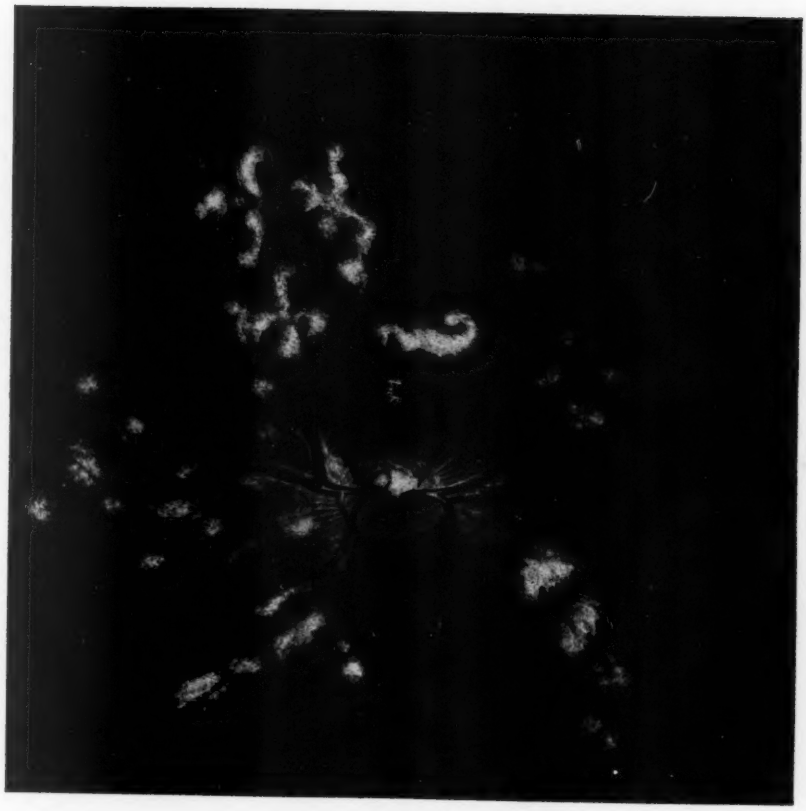

Fig. 1.—Lesion of the retina.

which became apparent thirty-five days following injury, after partial absorption of the white spots had taken place. The three cases reported by Vogt and Knüsel are of special significance. In their cases, the changes developed following a fall on the head, which did not cause fracture of the skull or loss of consciousness. Ophthalmoscopy was performed in a relatively early period, in the first case twenty hours, in the third case two days, and in the second case two and one-half days, following the injury. The observations in all of the cases were typical: Small white patches associated with retinal bleeding were already present. The case that I observed belongs in this group, and in certain respects enables one to deduct important observations in relation to the mechanism of these changes.

REPORT OF CASE

M. S., a man, aged 32, fell off his horse while taking a hurdle. The horse turned over and fell against the right side of the patient's thorax. The patient experienced a violent sensation of compression, but loss of consciousness did not follow. He mounted his horse immediately, and this time hurdled successfully. He had difficulty in breathing, however, which grew worse. He complained of delicate black spots in the front of the left eye. One hour later he dismounted. Later, he complained of violent backache and marked blurring of the vision in the left eye; the backache improved after a few deep inspirations. On the other hand, his vision became markedly worse. The small spots became large, and the dense opacities continued to increase in size. The following day pain in the chest was added to his symptoms. He consulted an oculist, who found a preretinal bleeding and a distinct cloudiness of the retina; in his opinion, the cloudiness was similar to that in the group described by Berlin. Ophthalmoscopy was first performed seven days following the accident; there were no visible signs of external injury. Laboratory and physical examinations gave negative results. The right eye was normal; vision was 15/20, and with plus 0.50 cylinder, axis 180, it was 15/15. The left eye was insensible to touch, and pathologic changes were not noted in the anterior parts. A delicate, movable opacity was visible in the posterior part of the vitreous. The disk was of normal color, with sharply outlined margins. Nasally and somewhat downward from the disk, a large preretinal bleeding, about three or four times the size of the disk, was present. Around the disk, especially temporally, numerous small, stripe-shaped, retinal bleedings were present. Below the course of the inferior macular vein a preretinal bleeding about half the size of the disk was also observed. Around the disk, in a circle about three or four times the size of the disk, but mainly around the macula, white shiny spots, varying in size from one-half to one disk, were seen along the vessels. A few isolated spots were located at the same distance from the veins, the bulk of the spots being grouped around the veins. The veins and occasionally the arteries were covered by the latter. The macular area was free from changes and was dark red; the macular and foveal reflexes were distinct. The small ribbon-like areas of bleeding were in the direction of the normal course of the nerve fibers. The veins were markedly dilated and tortuous, resulting in a darker tone of the latter at the point of deflection. The larger spots showed distinct bulging of the membrana limitans interna. The number of spots varied between twenty-five and thirty in the upper and nasal part, almost reaching the macular region. The formation of retinal folds between

the disk and the macula was conspicuous. Vision was 15/150; peripherally, it was somewhat better. The enclosed field of vision showed a few paracentral scotomas of diverse sizes (method of Bjerrum). The picture of the eyeground was made nine days following the injury, and therefore the changes had already partially cleared up. Treatment consisted of iodides given three times daily, sweating every other day and subconjunctival injections of a saline solution.

On the eighth day (fifteen days after the injury), the preretinal bleeding was greatly improved, the vitreous had cleared up completely, and the vision had improved to 15/30. During the following four weeks, the changes disappeared rapidly, and examination with the ophthalmoscope did not reveal any bleeding or spots. Only in the location of the former larger spots was a delicate haziness of the retina still noted. Vision was corrected to 15/15, with plus 0.50 cylinder, axis 180, but there were still small crescent-shaped paracentral scotomas.

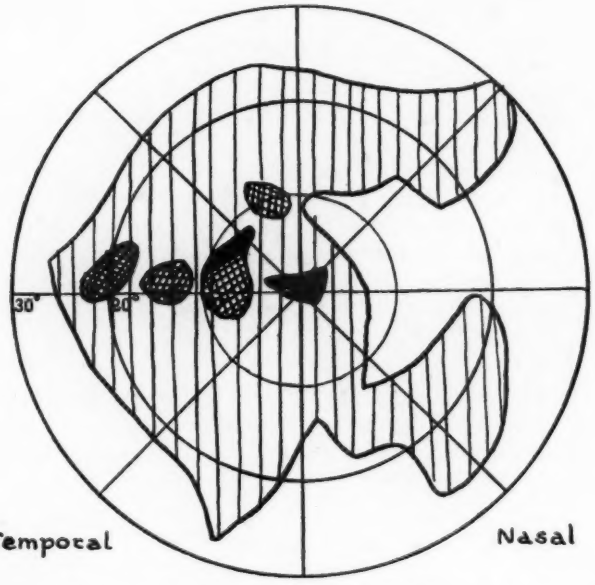

Fig. 2.—Visual field of the right eye. The solid black areas represent absolute scotomas; the crossed areas, relative scotomas, and the striped areas, hazy regions.

COMMENT

The foregoing case was caused by a fall from a horse, resulting in slight injury to the right side of the patient's thorax; there were no symptoms of a fracture of the skull and no loss of consciousness. The patient was even able to remount the horse after the fall and ride for an hour. The visual disturbances, however, manifested themselves immediately. The patient was examined for the first time seven days following the accident, and the typical picture described by Purtscher was found. Shiny, silvery white spots were observed in the inner retinal layers, with a predilection for the course of the retinal veins. The spots were distributed around the disk and in the space between the disk

and the macula, leaving the macular area free from changes. The size and shape of the spots varied considerably, the average size being from one-half to one disk. The picture was further confirmed by the presence of small point and ribbon-like retinal and large preretinal bleedings. The subjective symptoms of diminished vision and scotomas were expected in accordance with the objective observations. Furthermore, the rapid, easy clearing up of the pathologic changes in a relatively short time, resulting only in a fine temporal pallor of the disk and the presence of small paracentral scotomas, was characteristic and noteworthy. The clinical picture was comparable to that in albuminuric retinitis; this fact has already been mentioned by various authors. In explaining the developmental mechanism of the spots, Purtscher excluded the possibility of its being a transformation product of retinal bleeding. The latter possibility of development is contradicted by the rapid appearance of the spots following the injury (in the cases reported by Vogt and Knüsel, from twenty hours to two and one-half days following the injury). Purtscher attributed these changes to the mechanical impression of the cerebrospinal fluid.

According to Leber, the subvaginal space of the optic nerve is the direct continuation of the subarachnoid space and through the latter that of the ventricles, and so there is a possibility of an escape of cerebrospinal fluid through the subvaginal space in the direction of the eye. It is known that the cerebrospinal space ends blindly in the front, but at the same time experiments with injections show direct communication through the lymph spaces of the central vessels of the optic nerve with the supravaginal space, with the Tenon space and even with the suprachoroidal space. The increased pressure within the lymph spaces of the central vessels of the optic nerve may result in the mechanical pressing in of the fluid into the branch system, and the increased pressure of the perilymphatic spaces of the retinal vessels may lead to pathologic changes. A tumble from a horse is sufficient to cause a marked shortening of the spinal column although it lasts but a short time. This shortening will result in an exorbitant increase of pressure on the spinal fluid, causing an escape of the fluid into the cranial cavity with unusual force. The delicate membranes of the perilymphatic spaces are not built to withstand the excessive increase of pressure within and respond to the overfilling of the space with small ruptures of their walls. The ruptures of the walls enable the perilymphatic fluid to escape into the retinal tissue. A factor of utmost importance in explanation of the production of the white spots through the aforementioned mechanism is the fact that the location is always the papillomacular area, and even the area near the large retinal veins; it is well known that only the veins of the retina are provided with perilymphatic spaces. Not only the arrangement of the spots around the

veins, but their localization in the internal layers of the retina (partial covering of the vessels by the spots, bulging and the formation of folds in the membrana limitans interna) is strong evidence of the development of the spots through the escape of lymph from the normal anatomic spaces.

Purtscher could not thoroughly explain the clinical appearance of the silvery spots by the imbibition of the clear watery lymph into the retinal tissue. In his opinion, the spots mark not only the escaped lymph into the retinal tissue, but the deposits of foreign lymph material. Being misled by the color of their clinical appearance, he included the secondary changes as well, such as swelling of the axis cylinders, deposits of myelin and fatty degeneration of the glial tissue, all of which are of speculative nature owing to the lack of postmortem evidence. In that respect Purtscher's ideas closely approach those of Leber, who declined to accept the escape of clear fluid into the transparent retinal tissue as the sole cause of the production of the grayish-white spots. The escape of transparent fluid into the transparent tissue of the retina would result in spots invisible to the eye of the observer, and the peculiar color of the spot must be the result of secondary changes. However, the latter explanation of the spots is difficult in view of the clinical knowledge on the subject. If the color of the spots were the result of secondary changes alone, it would necessitate their late appearance following the injury, because the time necessary for the development of such pathologic changes would be considerable. The whole course of pathologic changes and the quick and traceless absorption of the spots, markedly contradict the possibility that this is a secondary manifestation. If one knew the supposedly serious nature of the absorption, one could hardly expect a complete restitution of the spots in a relatively short period; however, the total restitution within a short period is one of the outstanding characteristics of this picture. Furthermore, contradictory evidence to the foregoing explanation is found in the establishment and the clinical course of the changes. If the gray color represented secondary changes and not the escape of fluid, one would expect the spots to appear later after injury, and also to become more marked in the course of observation.

At the time Purtscher sought an explanation for his cases Koerber's case was the one in which the changes had been observed the shortest time following injury; even in that case the first examination of the eyegrounds was made six days after the trauma. Now there are the precise and important observations of Vogt and Knüsel, in which the changes have been described only twenty hours following the injury. The importance of the early cases is emphasized by the observation that the maximal changes appear immediately following the injury, and the changes are of diminishing and not of increasing nature. Vogt

and Knüsel are more than entitled to emphasize the clinical significance of that observation. The quick establishment of the spots following the injury and the marked and gradual restitution exclude the possibility that factors of importance other than the mechanical escape of fluid into the tissues may be brought into play. It would be hard to conjure with the possibility that within a few hours degenerative processes of such magnitude and scope would establish themselves as the clinical picture disclosed. If one accepted the former supposition, it would not be possible to explain the retrogression of the symptoms. Furthermore, the arguments of Purtscher and Leber that the mechanical escape and imbibition of clear and transparent fluid into clear and transparent tissue would not be visible to the observer's eye could not be looked on as completely covering the situation as recorded by Vogt and Knüsel.

Experience gained in a long series of experimental cases in which intralamellar injections of absolutely transparent clear fluids were made into the cornea taught me that after the injection of the clear saline solution, the diluted serum, the tuberculin (1 : 10,000,000) or the emulsion of bacteria, a grayish, cloudy bulge, resembling a blister appears. In the cornea of different animals, these grayish, bulging spots occur at the instant of injection and disappear completely within twenty-four hours, provided the injected fluid did not induce an inflammation or an infection. These facts are familiar to every research worker in this field, and the explanation must lie in the different refractive indexes. It seems more than plausible that Vogt and Knüsel were aware of these facts, and that they took these circumstances into consideration.

Critical analysis of the aforementioned facts leads to the inevitable conclusion that the establishment of the silvery white spots depends on the escape of fluid into the retinal tissue. The anatomic structure, the perilymphatic spaces around the veins, the arrangement of the spots along the course of the veins and the presence of small retinal and larger preretinal areas of bleeding are important proofs that the fluid escaped through small ruptures in the wall and was forced from the normal anatomic channel into the transparent retinal tissues. The rapid appearance of the spots, together with their prompt restitution, disproves the possibility of extensive pathologic lesions in the structural elements of these vulnerable tissues. Furthermore, my case shows that the clinical picture of the retinal spots not only may ensue as the result of serious fractures of the skull, but may be associated with compressions of the thorax, often of much less serious significance, in which the momentary shortening of the column leads to a sudden but marked increase of pressure on the fluid within. The explanation holds true only in typical cases; one finds so-called mixed cases in the literature in which, for example, the changes are associated with choked disk or with diffuse

cloudiness of the retina as described by Berlin. To the latter group belongs the case recently published by Farina;[8] to the former group, the case reported by Rübel.[9] In the clear cases not only is choked disk absent, but it is distinctly outlined and presents sharp margins. In cases of Purtscher's disease, the mechanism consists of a sudden but tremendous increase of intracranial pressure, while choked disk is characterized by a gradual increase in pressure, usually of much longer duration.

It is a moot question as to how cases complicated by choked disk should be classified. The relatively small number of cases to draw from does not permit distinct classification of the mixed types; only knowledge based on more cases and extensive study will supply data concerning these types. Whether there is any likelihood that borderline varieties or typical cases with complications of different origin may be included with atypical cases cannot be answered positively at this time. Purtscher counted the cases reported by Tietze[10] as belonging to that group with clinical changes. The spots appeared following rupture of the liver, but they were somewhat yellowish, and they were more deeply embedded in the retina. The simultaneous occurrence of embolic changes in the lungs permits the speculation that changes of similar origin may occur in the retina as well. Uhthoff's assumption, that in the cases reported by Tietze the marked secondary anemia due to profuse bleeding in the abdominal cavity responded by the establishment of the retinal spots must be considered as explanatory. Leber did not accept Purtscher's view that all of the cases reported by Tietze belonged to the same group; he was inclined to exclude the cases of compression of the thorax on account of the absence of ruptures in the walls of the perilymphatic spaces. He entertained the likelihood of an embolic origin; the crushed liver tissue may be present in the retinal vessels, just as it was demonstrated in the infarcts of the lungs. The latter explanation may apply to some of the cases, but it does not exclude the possibility that in other cases of thoracic compression the filling in of blood through the valveless veins of the neck and the region of the head will result in an increased intracranial pressure, which may produce an excessive lymphostasis and cause the well known clinical picture without rupture of the wall of the perilymphatic spaces.

As previously mentioned, Purtscher classified the two cases reported by Liebrecht in the earlier literature as belonging in the same group as

8. Farina: Klin. Monatsbl. f. Augenh. **85**:743, 1930.

9. Rübel, E.: Ein Fall von Purtscherscher Fernschädigung der Netzhaut durch Schädeltrauma, Klin. Monatsbl. f. Augenh. **78**:176, 1927.

10. Tietze: Verhandl. d. deutsch. Gesellsch. f. Chir. **1**:217, 1911.

my case. Liebrecht's first case was one of right-sided hemianopia, which was complicated by fracture of the occipital region of the skull, lesions of the brain and meningitis. Three weeks following the injury, during the course of the meningeal symptoms, Liebrecht found shiny, white, cloudy spots at and around the disks, which had irregular outlines and partly covered the blood vessels. Because of the edema, the margins of the disks were not sharply outlined, but choked disk was not present. The spots gradually decreased in size and disappeared after six weeks. Liebrecht's second case also presented a fracture of the skull. During the third week, double paralysis of the abducens nerve, bilateral total deafness, bilateral and almost complete paralysis of the trigeminus nerve, paralysis of the left side of the facial nerve and a bilateral choked disk of slight degree were noted. Three weeks following the injury, the first ophthalmoscopic examination disclosed numerous small and larger areas of bleeding at and in the region of the disk, associated with numerous white spots around the margin of the disk. If the slight hyperemic changes are not considered, the other parts of the retina were normal; in other words the picture presented was that of choked disk with fatty degeneration on and around the disk. In a later publication, Liebrecht reported that in cases of fracture of the skull the white retinal spots appear at least one week after choked disk develops. In cases of choked disk provoked by neoplasm of the brain, one occasionally finds small, white, retinal patches which are extremely sparse, both in number and in distribution.

Liebrecht was inclined to believe that the numerous white patches associated with choked disk caused by injury of the skull were fatty degenerations of the cells of the ganglions. He changed his opinion in accordance with the observations of Nakaizumi, who demonstrated that in cachectic retinitis the patches are produced by nests of variously degenerated nerve fibers and the deposits of fatty substances (the same changes were anticipated by Uhthoff in cases of pernicious anemia). In these cases, the primary lesion would be the crushing of the brain masses and the saturation of the lymph with the same. A lesion of the brain results in an edematous swelling that places the lymph in the brain under increased pressure, which, when reaching the disk, presents a marked stasis and through the presence of degenerated products results in a toxic disturbance of the blood vessels and nerve fibers.

Liebrecht claimed for his cases an origin and explanation different from those of Purtscher. It seems to me that there were marked differences in the cases reported by Liebrecht. I pointed out the presence of choked disk, even of slight degree; furthermore, the retinal spots did not appear until after one week, which was contrary to the early establishment of the spots following trauma in the early cases of

Purtscher's disease observed during their development. Staehli [11] was of the opinion that the changes in his case belonged in the same group as those in my case, but in his case there were marked differences. The lesion was bilateral and followed trauma, but there was a confluent, dense, white cloudiness of the posterior pole, covering a few areas in the retinal vessels and showing from twelve to fifteen small, round, atrophic spots in the center of the macular area. Finally, a lesion of the macula developed. The distinct chorioretinal changes were at variance with the mechanism of lymphorrhagiae retinae. Staehli tried to explain the changes in line with the views of Berlin's cloudiness, as being produced by transudation due to paralysis of the vessels of the retina and especially those of the choroid. In his opinion, Purtscher's disease is produced by a similar mechanism, the eyeballs being pressed toward the posterior bony walls of the socket, causing considerable compression and traumatism of the vessels, nerves and membranes, and finally resulting in the clinical picture described.

It seems to me still unproved that the cases reported by Tietze, Liebrecht, Staehli and Farina were the result of a clear lymphorrhagia of the retina. Two other possibilities should be seriously considered: Either the cases were lymphorrhagia of the retina complicated by changes of a different or secondary nature, or the changes in the clinical features closely resembled the picture of Purtscher's disease but were produced by a decidedly different mechanism. In a case reported by Liebrecht the presence of choked disk with the subsequent establishment of white retinal patches was of primary importance, while in that reported by Staehli the marked chorioretinal changes associated with permanent damage of the macular region were features that differed decidedly from the classic picture.

CONCLUSIONS

Typical lymphorrhagia retinae (Purtscher) appears within a short time following injuries of the head or the chest (the shortest time noted for the establishment was twenty hours following the trauma). In the majority of cases the changes are unilateral. Characteristic of the picture is the presence of isolated (sometimes confluent) white patches in the inner layers of the retina, partly covering the retinal vessels. The papillomacular area is the location of predilection. The spots are arranged along the course of the large retinal veins (the latter carry perilymphatic spaces). The disk, the macula and the periphery are free from changes. The superficial position of the spots results in bulging of the internal limitans membrane and a delicate fold formation of the retina. The changes are associated with punctate and ribbon-like retinal and larger

11. Staehli: Zur Kenntnis der Angiopathia retinae traumatica, Klin. Monatsbl. f. Augenh. **55**:300, 1915.

preretinal areas of bleeding. They are characterized by a tendency to rapid and complete disappearance. As the white spots disappear, formerly unnoticed, small, ribbon-like areas of bleeding are revealed. The spots usually disappear without leaving a trace, and the condition clears up completely without a disturbance in vision, but often a slight pallor of the temporal part of the disk or paracentral, crescent-shaped scotomas persist. The explanation given by Purtscher is satisfactory, especially in emphasizing that the cause of the spots is the fluid strangely deposited in new locations. The examination of future cases must establish the relationship of mixed or complicated cases to uncomplicated ones.

Ophthalmologic Review

THE RETINA AS A NERVOUS CENTER*

RAGNAR GRANIT, M.D.
PHILADELPHIA

It is well known that anatomically the retina is not only a receptor organ but a "true nervous center," to use the words of Ramón y Cajal, who discovered and traced its synaptic connections. However, there has been little appreciation of the part this synaptic structure plays in the mechanism of vision. This is due in part to the fact that the method of approach to visual problems has been chiefly by the interpretation of sensory data, which used alone do not allow of any differentiation between retinal happenings and processes in the brain; and in part to the fact that the attractive simplicity of the theory of duplicity has focused attention on the mechanism of the rods and cones and has hidden from many workers the real complexity of the problem. Recent progress in two related fields of physiology, however, emphasizes the importance of the synaptic functions of the retina, and in so doing indicates problems the solution of which will yield valuable information regarding some of the more fundamental aspects of vision. It is my purpose to outline in this paper the conception of the retina as a nervous center and to report some recent researches that show how this point of view may be used to advantage in a study of visual phenomena.

Of first importance to an understanding of the synaptic interaction between neurons is the work of Sir Charles Sherrington and his group of co-workers. Their brilliant work on reflex phenomena is gradually bringing order out of the chaos surrounding the mechanism of the central nervous system, and as far as the retina possesses many of the characteristic properties of the central nervous system, their work must be considered of basic importance to the science of ophthalmology. A second field of research that bears directly on the problems of vision is the recent series of researches by Prof. E. D. Adrian and his associates, in which they have recorded by means of vacuum tube amplifiers the action potentials in sensory nerves stimulated through their end-organs. In collaboration with R. Matthews,[1] he has employed his

* Submitted for publication, Feb. 24, 1931.

* From the Eldridge Reeves Johnson Foundation for Medical Physics, University of Pennsylvania.

1. Adrian, E. D., and Matthews, R.: J. Physiol. **63**:378, 1927; **64**:279, 1927; **65**:273, 1928.

remarkable technic for recording the nerve impulses in the long optic nerve of the Conger eel when the retina was stimulated with light. He thus found that on stimulation the retina discharged a series of impulses into the optic nerve the magnitude of which was independent of the strength of the stimulus, as was to be expected since nerve fibers act according to an "all-or-none" principle. However, there were two characteristics of the discharge that varied with the intensity of the stimulus: (1) the frequency of the impulses increased with the intensity of the light, and (2) the latent period of the outburst of impulses decreased with the strength of the stimulus. The first phenomenon has further been shown by Adrian and his successive collaborators to be a characteristic of the discharge from all sense organs as well as of the central nervous structures discharging reflexly (Adrian and Bronk [2]). This variation in frequency is an important determinant of the intensity of sensation and is one of the factors regulating the intensity of the motor response. However, the shortening of the latent period of discharge was found to be a better measure of the intensity of the physiologic processes in the retina than the frequency variation, because the large number of fibers in the optic nerve makes it difficult, if not almost impossible, to record the actual frequency of the individual units of the nerve responding.

By using the decrease in the latent period of discharge as the measure of increased intensity of retinal response, Adrian and Matthews [3] found that an increase in the area of the retina stimulated gave the same effect as an increase in the intensity of the light. The correct explanation of this spatial effect was obtained later,[4] when it was shown to be due to a synaptic reaction of the type generally known as spatial summation.[5] They proved this fact by studying the effect of four separated areas of illumination on the action potential in the nerve. When each area was stimulated alone, it was found that the latent period of discharge in the optic nerve was much longer than when all four areas were stimulated simultaneously. It was thus shown that the effects of the four separated areas interacted somewhere in the retina in such a way as to increase the intensity of the physiologic process that preceded the appearance of the discharge in the nerve. The simultaneous stimulation of four separated patches instead of one therefore gave an effect equivalent to that resulting from an increase in area.

2. Adrian, E. D., and Bronk, D. W.: J. Physiol. **66**:81, 1928.

3. Adrian and Matthews (footnote 1, first reference).

4. Adrian and Matthews (footnote 1, third reference).

5. In nervous centers spatially separated stimuli give a greater effect than each stimulus gives alone (Sherrington, C. S.: Integrative Action of the Central Nervous System, New York, Charles Scribner's Sons, 1906, p. 114).

The rods and cones are separated, but there is a dense net of lateral junctions furnished by the horizontal cells, the amacrines and the cells of the ganglionic layer, and by these paths separated stimuli may be able to reenforce each other through the process of summation. If this is the correct explanation, one would expect to find that the interaction between the four spots, resulting in an increased intensity of the physiologic process and a consequent reduction of the latent period, should be enhanced by the application of strychnine to the retina, which is known to increase synaptic interaction. This was definitely found to be the case. Adrian and Matthews therefore inferred that the process was identical with the familiar phenomenon of spatial summation as displayed by any central nervous structure with several paths converging on a common neuron. As pointed out by Sherrington,[6] on the basis of statistical considerations the amount of convergence should increase with the number of neurons activated; hence, an increase in the area stimulated would be equivalent to an increase in intensity.

These experiments have far-reaching consequences in the physiology of vision. They give a clear picture of interaction in the visual process, and because they were performed on the excised eye and the optic nerve, they show this to take place in the retina. However, an important question is to what extent these phenomena are reproduced by the entire mechanism, including sensation. As for the similar effects of area and intensity, it has indeed long been known that at the threshold of vision an increase in area may compensate for insufficient intensity of stimulation. Although by analogy with the similar results on the excised eye it is reasonable to suggest that they have a similar explanation in the basis of retinal summation, it must be pointed out that the phenomenon can and has been explained in a different way. However, if it is possible to repeat Adrian and Matthews' four spot experiment with sensory criteria and if it is possible to correlate the results with the structure of the retina and the general concepts of reflex physiology, the case for retinal interaction and spatial summation in the process of human vision would be much clearer.

In testing for this interaction between four separated areas of the human retina, it was not possible to use ordinary photometric methods based on an equalization of adjoining stimuli, since the effect to be looked for is mutual and hence would be eliminated by a procedure involving a comparison of brightness between two or more areas. The intensity of the retinal effect in the four stimulated areas was therefore measured by determining the fusion frequency of a flickering light. It is well known that this fusion frequency increases with the intensity of the stimulus and consequently measures the intensity of the physiologic process underlying the perception of brightness. The question to

6. Sherrington, C. S.: Proc. Roy Soc., s. B, London **105**:332 (Sept. 2) 1929.

be tested experimentally, then, is whether the fusion frequency for four separated areas stimulated simultaneously is higher than the value for any one of the areas illuminated separately.

The accompanying table shows typical results. The intensities were 94 and 0.94 meter candles, respectively, and the four illuminated spots were 1 degree in diameter, lying symmetrically on an imaginary circle 3 degrees in diameter. Experiments have been performed with central fixation and with the fixation point 10 degrees toward the periphery. The light was flickered by revolving a sectored disk in the beam.

A large number of well controlled experiments, as well as the one reported in the table, show that the four spots stimulated simultaneously give a higher fusion frequency than the areas stimulated singly. Here, then, as in the case of the experiments on the eel's eye, there is interaction between separated regions of the retina, the interaction producing a retinal effect equivalent to that resulting from an increase in the

Results of Experiments on Fusion Frequency *

	Central Fixation		Peripheral Fixation	
Intensity, Meter Candles	Fusion Frequency of Single Spots, Revolutions per Second	Fusion Frequency of all Simultaneously Illuminated, Revolutions per Second	Fusion Frequency of Single Spots, Revolutions per Second	Fusion Frequency of all Simultaneously Illuminated, Revolutions per Second
94.00	22.84	23.07	19.88	22.76
0.94	13.28	13.31	12.10	12.69

* From Granit, R.: Am. J. Physiol. 94 :41, 1930.

intensity of illumination. It is interesting to note that this phenomenon is especially marked in the periphery, which is anatomically similar to the eel's retina. In the eel's retina, the retinal connections are all particularly well developed, and many receptors converge on the ganglion cells, whereas in the human fovea the path from the receptor to the optic nerve fiber is more isolated. Indeed,

> Anatomically, the periphery of the human eye seems to be the nearest approach to that prototype of nervous pattern, which on evidence derived from work on motor neurones by Sherrington and his co-workers must be expected to display summation *par preference*.[7]

As previously pointed out, summation may be looked on as the physiologic expression of anatomic convergence of a number of paths to a common neuron. This view has here been put to an experimental test, and I think confirmed on the human eye in which different degrees of convergence can be obtained by varying the retinal location of the stimuli.

7. Granit, R.: Am. J. Physiol. **94**:41, 1930.

In central fixation there is less summation than in the periphery, but the power is by no means lacking. The foregoing experiment shows the amount of interaction in the fovea to be negligible, but more sensitive experimental tests reveal a definite effect. In certain experiments two semicircular areas of stimulation have been employed the distance of separation of which could be varied. With small distances between the two areas, an appreciable amount of summation was found in the center as well as in the periphery (Granit and Harper [8]). It is noteworthy that in such experiments the summative power frequently reached its maximum value when the two semicircular portions were still so far apart that the resolving power was not interfered with.

Since four separated areas of stimulation in the human retina interact to give summation of response, as indicated by an increase in fusion frequency, it should follow as a corollary that an increase in the area stimulated should also raise the fusion frequency. This has been shown to be the case by Miss Harper and me.[8]

The relation between fusion frequency of the flickering light and the area illuminated is given by the formula:

$$n = c \log A + d$$

in which n = fusion frequency, A = area, and c and d are constants. It will be seen that this expression closely resembles the well known Ferry-Porter law relating intensity and fusion frequency:

$$n = a \log I + b$$

In both cases the true curves represented by the equations are probably S-shaped, there being marked deviation from linearity at high and low intensities and large and small areas. The similarity of these two equations again emphasizes the fact that the fusion frequency varies with area of stimulus in the same general way as it does with intensity, although there are, of course, quantitative differences. What is more important, however, is that the variation of fusion frequency with area is decidedly greater in the periphery than in the center, whereas the variation of fusion frequency with intensity is less influenced by retinal location.

The statements in the preceding paragraph have indicated that peripheral vision is far more dependent on the area stimulated than is central vision. The two sets of experiments with variations in intensity and area offer a basis for a tentative explanation of this difference between central and peripheral vision, in which physiologic considerations are well substantiated by anatomic evidence. The general outline of the argument has already been set forth. The greater number of lateral connections in the peripheral retina makes the synaptic factor relatively more important in peripheral vision. Depending on the degree of summation, the peripheral sensitivity to light in daylight vision may be lower, equal to or higher, than the central sensitivity. There is therefore no absolute difference between the values of fusion frequencies

8. Granit, R., and Harper, P.: Am. J. Physiol. **95**:211, 1930.

for the center and the periphery,[8] as these frequencies are a function of both the area and the intensity of the test object used. With a sufficiently large area of stimulation and a relatively high intensity, the summation in peripheral vision may even overcompensate for its lower sensitivity. The following statement by Parsons[9] is therefore easily explained by our results:

> There is overwhelming proof, derived from peripheral luminosity curves, minimal field and minimal time luminosity curves, that peripheral vision behaves in exactly the same manner as central vision but with diminished sensitivity. Greater stimuli are required to produce similar responses, but if the stimuli are sufficiently great, the differences disappear, including even qualitative differences so that the fields of vision for colors extend to the extreme periphery.

Evidently, the theory of duplicity, the aim of which is to account for regional differences in the field of vision by the different distribution of rods and cones in the retina, is too great a simplification of retinal physiology. The synaptic aspect enters as a serious complication, but nevertheless one that can be profitably attacked.

Consider, for instance, the influence of the spatial factor on the mechanism of local adaptation. Although fairly conclusive evidence (Granit and von Ammon[10]) shows this phenomenon to be chiefly determined by processes in the receptors, let us see what influence the synaptic structure may have on this mechanism? It is well known that the rate of local adaptation in the fovea is low and that it is much greater in the periphery—so much greater, in fact, that the large decrease in apparent brightness during the first few seconds as a result of the adaptation is easily measurable by the flicker method. We have investigated the effect of area on the rate of peripheral adaptation and have found that there is a considerable drop in apparent brightness (decrease in fusion frequency) during a fixation time of 3 seconds, but that by increasing the area of illumination the intensity does not drop to as low a final level of equilibrium as with a small area. In terms of the synaptic concepts of retinal function, this may be explained by saying that the decrease in excitability of the receptors through adaptation is to a certain extent compensated for by an input over lateral channels. For the larger the area stimulated the more efficiently is any one neuron within the stimulated area charged by virtue of the effect of adjacent neurons. The excitatory state is better sustained the greater the number of paths converging on the neuron, and thus the adaptive effect is retarded and checked. The synaptic system in this case serves as a "buffer." The rapid adaptation of the peripheral receptors would seriously hamper peripheral daylight vision if it were not for the buffering effect with

9. Parsons, J. H.: Theory of Perception, London, Cambridge University Press, 1927, p. 177.

10. Granit, R., and von Ammon, W.: Am. J. Physiol. **95**:229, 1930.

large areas. It is indeed well known that small areas do disappear altogether if fixated for a few seconds, and in the same way differences of detail are smoothed over.

By virtue, then, of its great summative power the peripheral eye is in a remarkable manner able to cooperate with the fovea at high intensities, whereas at low intensities dark adaptation makes it especially sensitive to light. The two processes, summation and dark adaptation, make the periphery an efficient organ throughout the enormous range of intensities within which vision is possible. The fovea, as is well known, is a special organ for the upper part of that range only, is blind in darkness and has properties with regard to refraction and isolated conduction which meet the demands for discrimination of brightness and visual acuity. On the other hand, "the peripheral retina is adapted to the limitations set to it by the refractive system. It has little visual acuity and great summative power" (Granit, Hohenthal and Uoti [11]). It is the more primitive organ, but it is admirably well equipped for the elementary function of perceiving gross differences of light under all conditions of illumination. As it is much larger than the fovea, it can afford to be dependent on stimuli of greater area for proper evaluation of the peripheral brightness conditions. In short, the two regions, periphery and center, are extremely different as regards the adaptability and sensitivity and could not cooperate at all in daylight vision if it were not for the stabilizing and sensitizing influence of the synapses. There may indeed be pathologic conditions in which these synaptic influences are impaired, and it should be possible to detect these conditions if clinical tests were designed to ascertain the amount of summative power instead of merely measuring, as at present, the visibility regardless of how it is brought about.

Increased emphasis on the synaptic concept in the physiology of vision leads to many problems suggested by the facts and theories of reflex physiology. Several have already been discussed: Of the many remaining, I shall consider briefly the so-called temporal summation of subliminal stimuli. For instance, it is well established that a number of successive stimuli that individually are incapable of eliciting a scratch reflex may do so if repeated for some time. Eccles and Sherrington [12] have employed this phenomenon as a means for studying the time course of excitation in the spinal cord. They employed two subliminal stimuli separated by varying intervals of time, and the amount of reflex contraction elicited by the second stimulus was taken as a measure of the "central excitatory state" left by the first. Repeated tests showed that neither of them was sufficiently strong to elicit any contraction alone.

11. Granit, R.; Hohenthal, T., and Uoti, A.: Acta ophth. **8**:137, 1930.

12. Eccles, J. C., and Sherrington, C. S.: J. Physiol. **69**:1, 1930.

In collaboration with W. A. Davis, I have recently been performing similar experiments on the human eye.[13] Two subliminal stimuli have been used, and the time interval between them has been varied. It has been found that when this interval is lengthened, it is necessary to increase the second stimulus in order that it may be sufficient to raise the remaining subliminal state of excitation above the threshold of perception. As the interval between the two increases, the second stimulus must be increased until it finally reaches a liminal value. For instance, in the dark-adapted periphery it is found that the state of excitation reached with the first subliminal stimulus may remain at a nearly constant level for as long as 0.045 second and that it then falls off gradually, being still appreciable at about 0.135 second, at which time the second stimulus has to be made as strong as the first. The maximal duration of an effective residual excitatory state, that is, the maximum interval within which two subliminal stimuli will sum, has not yet been established. It must be obvious that such data may be used to trace the time course of excitation and give interesting information regarding the nature of the threshold of vision. In common with many other visual investigations suggested by synaptic considerations, such experiments yield valuable information for the student of reflex physiology and neurology.

Because the retina has a synaptic structure similar to that of the central nervous system but simpler in both arrangement and function, it may be hoped that the ophthalmologist may be able to contribute much to the elucidation of the difficult problems of nervous function. About thirty years ago an attempt was made by Braunstein[14] to use the flicker method for clinical work. His results showed that the fusion frequency decreased in certain pathologic conditions and suggest that with the methods of analysis presented in this paper it should be possible to arrive at a more detailed understanding of the nature and retinal localization of the physiologic processes underlying the general symptom of decreased visibility.

13. Granit, R., and Davis, W. A.: Am. J. Physiol., to be published.
14. Braunstein, E. P.: Ztschr. f. Psychol. **33**:171 and 241, 1903.

News and Notes

GENERAL

Central London Ophthalmic Hospital.—A new wing at the Central London Ophthalmic Hospital was opened by the Princess Marie Louise on March 5, 1931. This wing is four stories high and was erected to meet the demand for the accommodation of patients able to contribute toward their treatment and maintenance, though not able to afford an expensive nursing home and consulting fees. A plan is being executed whereby patients whose incomes are within a certain limit can obtain private consultations for a moderate fee. Mr. M. S. Mayou, senior surgeon to the hospital, believes that clinics for people of moderate means will prove an important factor in the future history of voluntary hospitals.

Moorfields Dinner.—The annual dinner of past and present students of the Royal London Ophthalmic Hospital was held at Langham Hotel on Feb. 12, 1931. The chairman was Mr. A. H. H. Sinclair, ophthalmic surgeon to the Edinburgh Royal Infirmary. The dean, Mr. Charles Goulden, in presenting his report, spoke of the enlargement of the outpatient department and of library, laboratory and teaching facilities. Accommodations have been added for private patients. There were 160 students in attendance at the hospital in 1930.

Hughlings Jackson Memorial.—A fund is being raised to establish a permanent memorial to Dr. Hughlings Jackson. Among those who are taking action in the matter are many old friends and pupils who revered and loved Jackson, and who recognize to what extent the pre-eminent position of British neurology in the medical world is due to his work and influence. It is hoped to raise an amount sufficient to provide a permanent endowment for the Hughlings Jackson Lecture, given every third year before the Section of Neurology of the Royal Society of Medicine. Dr. Wilfred Harris, of 56 Wimpole Street, London, W. 1, has consented to act as treasurer of the fund, and subscriptions should be sent to him, marked "Hughlings Jackson Memorial Fund."

—From the *British Medical Journal.*

International Association for Prevention of Blindness.—The International Association for the Prevention of Blindness represents a united attempt on the part of ophthalmic surgeons of all nationalities, working in conjunction with the League of Red Cross Societies, to reduce the incidence of blindness throughout the world, particularly in those countries in which little is being done in this direction. According to the statistics, there are today more than 5,000,000 sightless persons in the world. Where a detailed investigation has been made, the number is found to be three times as large. All who realize that at least from 50 to 60 per cent of this blindness need not have

occurred, applaud the International Association for the Prevention of Blindness, and share a feeling of satisfaction that work, long overdue, has at last been begun. In attempting to deal with a problem of these dimensions, the first thing to be considered is finance, and those who are willing to give will naturally want to know how the money is spent. The answer to their question is that the method must be one of propaganda. Through this medium it is possible to stimulate national interest in this terrible disability, to encourage investigation into its causes, to indicate measures for combating those causes, to promote the formation of societies for the prevention of blindness in the countries in which there are none and financially to aid such societies as already exist. The International Association for the Prevention of Blindness will launch, at some future time that is more favorable for a financial project, a world-wide appeal; meanwhile, a national committee is being formed in every country affiliated with the association.

Chloroform Centenary.—Three distinguished scientists working independently, one in Germany, one in France and one in America, discovered chloroform the same year, 1831. The American, Dr. Samuel Guthrie, made his discovery on Oct. 12, 1831, at Sacket Harbor, N. Y., while experimenting with bleaching powder and alcohol. He called the product "spirituous solution of chloric ether." Dr. Guthrie was born in Brimfield, Mass., in 1782, and he served as a surgeon in the United States Army during the War of 1812. Later he invented the punch-lock to replace the old flintlock musket. Dr. Guthrie died in 1848, when chloroform was first coming into use as a general anesthetic.

Annual Meeting of North Dakota Academy of Ophthalmology and Oto-Laryngology.—The thirteenth annual session of the North Dakota Academy of Ophthalmology and Oto-Laryngology and the Section on Ophthalmology and Oto-Laryngology of South Dakota was held June 2 at Aberdeen, S. D. Papers were presented by Drs. Thomas W. Allen, Chicago; Bert H. Hempstead, Rochester, Minn.; W. L. Diven, Bismarck, N. D., and W. R. Winn, Fargo, N. D. Drs. F. L. Wicks of Valley City and W. L. Diven of Bismarck were elected president and secretary, respectively, of the North Dakota group.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Bacteriology and Serology

THE BACTERIAL FLORA OF THE NORMAL CONJUNCTIVA WITH COMPARATIVE NASAL CULTURE STUDY. R. A. KEILTY, Am. J. Ophth. **13:** 876 (Oct.) 1930.

One hundred persons with normal eyes were used in a study. Cultures from the eyes and the nose were obtained by swab, and were streaked across blood-agar plates which were incubated for forty-eight hours at 37.5 C. Several tables are presented to show the results obtained in the cultures from the eyes. From the relationship of these to the cultures from the nose, the author concludes that the tear ducts act as pathways of infection either directly or by lymphatic drainage. The severity of the infection in the eye and that in the nose also seemed to correspond.

The author concluded that the majority (57 per cent) of normal conjunctival sacs carry one or more organisms on one or both sides, without clinical evidence of inflammatory reaction of the conjunctiva, while a minority (43 per cent) are sterile, as measured by swab plantings incubated for forty-eight hours on blood agar plates.

The organisms that were isolated in this series belonged to the pathologic group and were types that are generally considered low in virulence but of the suppurating variety. The large white colony of hemolytic staphylococci characteristic of the nasal flora markedly predominated. From these observations, all conjunctival sacs must be considered as harbors of micro-organisms unless proved otherwise. This fact has a decided bearing on possible postoperative infection in otherwise clean incisions into the eyeball, especially in cases of cataract.

W. S. REESE.

Cornea and Sclera

CATAMENIAL EPISCLERITIS. H. VILLARD, Arch. d'opht. **47:** 534 (Aug.) 1930.

Villard reports an unusual case of episcleritis in a woman which had occurred over a period of five years with uniform regularity from eight to twelve days prior to the onset of menstruation. The taking of a small amount of blood for a Wassermann test eight days prior to the onset of menstruation resulted in the failure of the episcleritis to appear. A similar occurrence was noted following the removal of blood for the determination of the urea content. Subsequently, on the request of the patient, repeated bleeding averted the episcleritis. When this was not done, the episcleritis always appeared. The author calls attention to the coincidence of the time of appearance of the episcleritis, from eight to twelve days before the onset of menstruation, with the time of the formation of the corpus luteum. He has no satisfactory explanation for this relationship. He suggests, however, the possible benefit bleeding might give if another similar case presented itself.

S. B. MARLOW.

General Diseases

OCULAR ACNE ROSACEA. J. VERDAGUER, Arch. de oftal. hispano-am. 30: 409 (Aug.) 1930.

After calling attention to the similarity of the pathologic lesions of ocular acne rosacea and those of the corresponding disease of the skin, the author classifies the different clinical forms according to their topography into palpebral, conjunctival, corneal and scleral cases. The palpebral form is found in some patients with acne, as an erythematous squamous blepharitis; it is rare to find the nodules of acne on the skin of the lids. The conjunctival variety may effect a diffuse or a nodular form; the congestion in the former is characteristic: dilated blood vessels appear next to the normal vessels, with a rectilinear instead of the usual flexuous course, there being scarcely any secretion. The nodular variety presents grayish infiltrations, the size of a pinhead, in the center of a plaque of conjunctival congestion, there being no tendency to ulceration as found in similar lesions of phlyctenular ophthalmia. The corneal forms are especially interesting and at times very serious. They present a great variety of lesions; occasionally, there are small ulcers with slight surrounding infiltration, such as are seen in scrofulous subjects. In other cases, large, dense, yellowish-gray nodules of corneal infiltration are found, which are extremely vascular, as in facial rosacea. They are rebellious to treatment and frequently recur. The prognosis is poor, some cases progressing to blindness, in spite of different methods of treatment. The author has not observed scleral cases.

After remarks on the diagnostic features and on the appropriate therapeutic measures, which are inconstant, the author reports three cases.

C. E. FINLAY.

A NEW CASE OF CROUZON'S DISEASE. J. ARJONA, Arch. de oftal. hispano-am. 30: 650 (Dec.) 1930.

A case is reported in a girl, aged 9 years, which seems to have originated in a meningeal attack when the patient was 7 months of age. The patient's intelligence was normal. The manifestations of the disease consisted in a tower-shaped cranium, with a central bony thickness which commenced at the lambda, extended along the sagittal suture, was most pronounced at the bregma, diminished along the interfrontal suture and disappeared at the root of the nose. To either side of the prominence the curvature of the cranium was less pronounced than normal, the shape of the cranium being clearly of the trigonocephalic type. The superior maxillary was ill developed, the nose was beak-shaped, there were an irregular implantation of the teeth and an arched palate, and the lower jaw was prognathic. There were bilateral exophthalmos and pallor of both disks, with a reduction of vision to 1/6 and 1/10.

The author discusses the roentgenographic details and reviews the literature on the subject. He is inclined to accept the disease as a pathologic entity, in opposition to German authors who consider it a variety of oxycephalia. He does not agree with Crouzon in a dermatologic origin, and finds the etiology and pathogenesis obscure.

C. E. FINLAY.

Glaucoma

THEORETICAL AND PRACTICAL NOTES ON GLAUCOMA. C. HAMBURGER, Am. J. Ophth. **13:** 847 (Oct.) 1930.

The author discusses the lowered ocular tension that accompanies inflammations, and cites two cases of iritis in which the tension dropped and remained low for one and three years, respectively. In a third case, in a woman, aged 56, with diabetes and severe simple glaucoma (not responsive to miotics), bilateral iritis developed during which the tension dropped below 20 mm. Miotics and glaucosan (an epinephrine substitute) had not been used for the past three years, though the tension had been recorded once or twice monthly.

The author believes that ciliary inflammation is the softening principle in both the operative and the medical treatment for glaucoma. He therefore cauterizes the cornea near the upper nasal limbus with a silver nitrate stick. He cites a case in which the tension increased despite iridectomy and Elliot trephining, but fell to 20 mm. or less after cauterization and remained low for two months. He discusses the use of glaucosan, and presents the following summary:

"I endorse the words of Gifford, in the paper mentioned above: 'All methods of treatment demand careful watching of the vision, fields and tension, so that the progress of the disease may be noted early enough for effective surgical intervention.' That is the present state of our knowledge. But since simple glaucoma and inflammation—broadly speaking—are antagonistic conditions, that is, since in spite of some exceptions inflammation (acute, ciliary) diminishes tension, science must unceasingly endeavor to find a form of inflammation capable of being controlled and limited and which renders the eye soft without operation. For operating on an eye with vision always involves great responsibility. The goal is not yet won, but the way leading to it is indicated."

W. S. REESE.

TREPHINING IN THE TREATMENT OF CONGENITAL GLAUCOMA. R. E. WRIGHT and K. KOMAN NAYAR, Brit. J. Ophth. **15:** 166 (March) 1931.

The authors state that in common with other observers they have sometimes found the treatment for congenital glaucoma very disappointing, and it was therefore with some satisfaction that they recently observed the effects of successful trephining in two cases. Posterior sclerotomy as an operative treatment in any condition of the eye has always seemed to them a remedy to be avoided if some less drastic procedure can be adopted.

The success or failure of an anterior decompression must largely depend on whether the normal relationship of the aqueous and vitreous is preserved; and the changes that result in the zonule and the vitreous body itself, as a result of stretching of the globe, eventually upset this relationship in certain cases.

They also reported a somewhat unusual group of cases of congenital glaucoma suggesting familial sex-linked characters.

W. ZENTMAYER.

Injuries

SELF-INFLICTED MUTILATION OF THE EYES PERPETRATED BY INDELIBLE PENCIL. J. WOLFF, Klin. Monatsbl. f. Augenh. **85:** 548 (Oct.) 1930.

Severe injuries to the eyes were brought on intentionally by a number of criminals, for the purpose of obtaining release from the penitentiary. The author reports five cases in which shavings and larger pieces of indelible pencil were placed in the conjunctival sac. Irritation followed promptly, but the men were clever enough to hide it until irreparable damage had been done. Particles of the substance remained in the conjunctival sac of one man for two months, finally causing destruction of the eye. The pathologic changes in these cases were considerable, leading to necrosis of the conjunctiva, large perforating ulcers coupled with iridocyclitis, perforation of the cornea and phthisis of the globe. In one case, extensive symblepharon of the corneas of both eyes resulted; in another, sloughing of both corneas occurred, requiring the removal of both eyes; in this case the substance was in the conjunctival sac of one eye for twenty-four hours and in that of the other for six days.

K. L. STOLL.

TREATMENT OF LESIONS CAUSED BY INDELIBLE PENCILS. A. VON PFLUGK, Klin. Monatsbl. f. Augenh. **85:** 669 (Nov.) 1930.

The author opposes removal with the knife of the tissues impregnated with the caustic substance of the indelible pencil and the flushing of the wound with a solution of tannic acid or hydrochloric alcohol. He obtained good results in a number of cases of caustic burns of the conjunctiva and cornea after cocainization in the following manner: Every particle of the pencil was removed with a needle for removing foreign bodies under constant flushing with a weak solution, about 10 per cent, of hydrogen peroxide. Discoloration of the tissues began instantly. Next Birsch-Hirschfeld's lamp was used for ten minutes at a distance of 15 cm., while a stream of physiologic solution of sodium chloride was allowed to run over the eye repeatedly. An ointment of cocaine was placed in the conjunctival sac, and the eye was bandaged. In intensive burns, the conjunctival sac is flushed, and the lamp is used for a shorter time, twice daily. Recovery followed promptly in all of the author's cases; the point of the pencil, however, had not entered the globe in any case. Perforating wounds caused by an indelible pencil may be treated successfully, provided the foreign substances can be eliminated without loss of time.

K. L. STOLL.

INTRA-OCULAR MAGNETIC FOREIGN BODIES. P. VANCEĂ, Cluj. med. **11:** 552 (Nov. 1) 1930.

The author presents a discussion of the literature and the generally adopted points of view in regard to the pathology, localization and therapeutics of intra-ocular magnetic foreign bodies. The author gives preference to the method of localization by roentgenography worked out by Koehler and Holzknecht, which permits the making of five succesive exposures on the same plate: the eye looking straightforward, to the

right, to the left, upward and downward, the x-ray bulb being immovable and the eye motile. The physiologic method suggested by Belot and Fraudet offers the same advantages. For smaller foreign bodies, the skeleton-free roentgenography of Vogt is the best. For the indentification of intra-ocular foreign bodies, especially iron, chemical analysis of the aqueous humor by Coppez' method can be resorted to. Besides roentgenography, the electromagnet is still the most important diagnostic aid in the identification of intra-ocular, iron-containing foreign bodies.

The prognosis of intra-ocular foreign bodies is poor, since intra-ocular, suppurative lesions may arise; injurious chemical processes (by iron, copper or lead) lead to loss of the eye. Therapeutically, there is only one course to be taken, i. e., the removal of the intra-ocular foreign body. The author reviews forty-two cases of intra-ocular foreign bodies. Twelve were located in the anterior segment of the eyeball, i. e., two in the anterior chamber, three in the iris and seven in the lens. In thirty cases the foreign body had lodged in the posterior segment of the eyeball. In twenty-one of the cases diagnosis was made by means of roentgenography, in ten cases by a giant electromagnet and in eleven cases by both methods. In thirty-eight cases there was a single foreign body, and in the remaining four cases multiple ones. The route mostly used for their removal was that through the sclera. The extraction was successful in twenty-two cases and failed in four, while enucleation was performed in sixteen. Vision was functionally sufficient in 14.28 per cent and insufficient in 85.27 per cent of the cases. Foreign bodies situated in the lens are tolerated best, then follow, in the degree of tolerability, those freely lodged in the vitreous body. The foreign bodies lying in the ciliary body and choroid are the most dangerous. In all cases of intra-ocular foreign body, instantaneous extraction, if feasible, should be the method of choice. If it is impossible to remove the foreign body, the injured eye should be kept under close control, in order that enucleation may be carried out, if necessary. N. BLATT.

Lens

SOME DETAILS ON THE INTRACAPSULAR EXTRACTION OF CATARACT. M. VAN LINT, Arch. d'opht. **47**: 380 (June) 1930.

In this paper Van Lint describes in detail his operation for the extraction of cataract in capsule. It differs from the classic operation in that the incision is made on the temporal side of the cornea. After a large conjunctival flap has been dissected, a keratome is first used to open the anterior chamber. The wound is then enlarged with scissors and a small peripheral iridectomy done as high up as possible. Barraquer's instrument is then introduced from the side, where there is more room for its manipulation, and the lens is removed in capsule. The steps of the operation are minutely described. S. B. MARLOW.

Lids

RAT BITE OF THE EYELIDS RESULTING IN RAT-BITE FEVER. C. M. SWAB, Am. J. Ophth. **13**: 884, (Oct.) 1930.

A Negro boy, aged 6, was bitten on the left eyelid by a rat. Two weeks later the eye and the left side of the face became so swollen that the eye could not be opened. There was no pain, but some fever.

Examination showed an edematous swelling of the left lids. The temperature was 100.4 F. At the outer canthus were two depressed marks in the skin of the lids, one in each lid, that in the upper lid resembling the impression of a rat's tooth and being fully healed. The wound on the lower lid was covered by a rather heavy crust, which on removal disclosed a fully healed lesion of the skin. The conjunctiva was somewhat edematous and injected, but all of the other ocular structures were normal. There was a marked, firm swelling of the anterior cervical lymph glands on the left side. A blood count showed 4,800,000 erythrocytes, 10,500 leukocytes, with 70 per cent polymorphonuclears and 85 per cent hemoglobin. A Wassermann test was not made.

The patient improved under treatment with neoarsphenamine, and was discharged at the end of sixteen days with only slight edema of the lids.

W. S. Reese.

Neurology

Is There a Morphologic Symptom-Complex of the Iris in Tabes Dorsalis and Dementia Paralytica? P. Vancea, Cluj. med. **11:** 177 (April 1) 1930.

In order to convince himself of the existence of the symptom triad of the iris as described by Tieri and other authors in people affected by tabes dorsalis or dementia paralytica, the author submitted twenty-two patients with dementia paralytica and six with tabes dorsalis to examination. The triad of symptoms described by Tieri consists of atrophy of the tissue of the iris, irregularity of the pupillary contours and anisocoria. The clearing up of this question is not only of diagnostic, but also of pathologic, importance, because a number of authors are inclined to explain the genesis of Argyll Robertson's pupil by atrophy of the iris. In the twenty-eight cases observed by Vancea, atrophy of the iris existed in eight cases, irregularity of the pupil in four and anisocoria in thirteen. There was no one case in which all three symptoms—in the sense of Tieri's triad—were met with at once. In two cases trophic lesions of the iris and anisocoria coexisted, and in one case, atrophy of the iris together with irregularity of the pupil. Hence, the author asserts that there is no such morphologic symptom-complex of the iris in tabes dorsalis and dementia pralytica. He found, however, a complete absence of photomotor pupillary reflexes in the cases in which there was a trophic lesion of the tissue of the iris. He feels, therefore—in agreement with other authors—that the absence of the photomotor pupillary reflexes is usually preceded by trophic disturbances of the tissue of the iris.

N. Blatt.

Ocular Muscles

Occupational Nystagmus in Train Dispatchers. C. P. McCord, J. A. M. A. **96:** 1131 (April 4) 1931.

The author reports that among 121 train dispatchers examined in widely separated sections of the country from seventeen railroads, occupational nystagmus has been detected in eighty-one, or 87 per cent. In addition, in two cities, among thirty persons examined, twenty-two, or 70 per cent, presented this condition.

The nystagmus found was essentially horizontal, with marked variation in the rate of motion, and with some variation in the rates for the two eyes.

The nystagmus of train dispatchers appears to be unassociated with aural conditions, although occupational deafness was noted in 56.2 per cent, and was more commonly present in the left ear, on account of the wearing of the hearing mechanism on that ear. It is believed that the noises common to the dispatching of trains are responsible for occupational deafness.

The nystagmus encountered among train dispatchers is accepted as of occupational origin and is attributed to the continued motion of the large paper train sheet beneath the eyes and the movement of the head and eyes over the sheet, both of which are necessary in the continual recording of data concerning the movement of trains.

It is maintained that the high frequency of the use of the eyes in connection with work on the train sheet leads to overworking of the ocular mechanism, resulting in a nervous syndrome characterized by nystagmus, blepharospasm, some visual impairment and ocular discomfort.

The occupational nystagmus of train dispatchers is less severe than the average nystagmus of miners, and no case has been encountered that in itself could be accepted as the cause of total disability.

W. ZENTMAYER.

AN INVESTIGATION OF MINERS' NYSTAGMUS. W. J. ROCHE, Brit. J. Ophth. **15:** 211 (April) 1931.

Two hundred and twelve cases of miners' nystagmus in South Wales were studied in detail in the consulting room, in a dark room, at the pit head and underground. The men doing colliers' work are most often affected. The frequency of the disease among haulers, timbermen and repairers is slight in comparison. Four types of nystagmus are recognized: (1) latent, (2) subacute, (3) acute and (4) the neurasthenic stage.

In the latent type, nystagmus was noted only after the shift; the oscillations were temporary and were present only while the patient was giddy. In the subacute type, headache, frontal or occipital, dazzling of light while working or in an awkward position, particularly toward the end of the shift, poor sight in the twilight and giddiness for a few hours after work may be complained of. The symptoms may be oscillations, photophobia, giddiness on bending and lowering of visual acuity, with a characteristic slowness in picking out the letters on the chart. In the acute type, the aforementioned symptoms are aggravated and photophobia associated with spasm of the lid, of the elevator muscle or of both is present. Oscillations of the eyeball are nearly always present, sometimes slow, 100 to the minute, and sometimes fast and fine, from 200 to 350 per minute. The term rotatory is a misnomer, as the oscillations are not a complete rotation but are pendulum-like. In the fourth type, neurasthenic symptoms are added to the other signs of the disease.

The author considers vertigo as the most incapacitating symptom. It is impossible to associate nystagmus with any particular age.

While the author agrees with those who consider defective illumination the principal cause of nystagmus, he is not in agreement with their forecast that with improved illumination the disease will cease almost entirely, because since the introduction of electric lamps the disease has increased considerably. He believes that this is not directly due to the introduction of electric lamps, but to the fact that the men who have become incapacitated are those who suffered from latent nystagmus while using oil lamps; that is, when they changed to electric lamps, the irritation of the brighter light aggravated the disease. He is of the opinion that the primary cause of nystagmus is deficient illumination, and that the principal secondary cause is malposition at work.

He suggests that miners' nystagmus is a nonorganic disease, whereby the coordinate movements of the body, particularly of the eyes, have become incoordinate, owing to the altered afferent impulses received from the eyes and the ears and the consequent altered reflex efferent impulses transmitted to the musculature.

The author feels confident that the 4 candle power Concordia alkaline lamp is sufficient, the workers using macular and perimacular vision, which, in his opinion, is necessary if nystagmus is to be avoided.

Among other subjects, the investigation covers errors of refraction, association of accidents with nystagmus, association with an acute illness, comparison of lamps, effects of after images on accuracy of vision, tests of the muscles, etc.

The author makes the following recommendations:

The ideal lamp is the cap lamp.

The alternative to the cap lamp is the 4 candle power electric lamp.

All lamps should be frosted and, in addition, should have a slight green tint.

Going to and returning from work, an opaque shade should be fixed to the pillars on the back of the lamp to avoid glare.

An endeavor should be made to improve the ventilation generally. Better ventilation will mean more production of coal.

The sons of men who have been known to have nystagmus should not be employed under ground.

Men returning to underground work after an attack of nystagmus should not be given colliers' work in the beginning.

Suitable glasses, for either the prevention or the cure of nystagmus, are of little avail.

Men with nystagmus would be well advised to change their occupations if possible.

Many of the continued cases from previous years are in neurasthenic persons who would be better doing light employment; they would gradually regain their confidence.

Certifying surgeons should be ophthalmic surgeons, given discretionary powers to decide which patients are or are not incapacitated and for what type of work they are suited.

There should be better illumination on main roadways, stone dusting, whitewashing, etc.

W. ZENTMAYER.

PARALYSES OF THE MUSCLES OF THE EYES. Z. SPANIEL, Dissertation, 1930.

The author discusses palsies of the muscles of the eye in general from the point of view of general practice, and deals statistically and critically with the corresponding cases observed at the ophthalmologic clinic of Jassy. The classification and sequence of the material are valuable and to the point, from both the practical and the clinical point of view. There follow in succession a discussion of the anatomy of palsies of the muscles of the eyes, the biologic purpose, anatomic symptoms, functional symptoms, the special discussion of each particular muscle, the differential diagnosis, the course and disease of the various muscles, etiology, location of the morbid focus, prognosis and, finally, the therapy for the palsies. In 55 of 5,695 cases of diseases of the eye which occurred at the clinic at Jassy, there were paralyses of the muscles of the eyes, thus totaling 0.98 per cent. Etiologically, syphilis plays the principal part (42.27 per cent), particularly its delayed manifestations. The external rectus and the superior oblique were the muscles of the eyes most often affected. The prognosis of the palsies is first and foremost dependent on the primary disease. One ought always to count on a long duration and recurrences of the paralyses. Therapy should attack the primary disease and should be aided at the same time by local treatment (electricity and injections of strychnine). Surgical intervention should be resorted to only when one is sure of dealing with a stationary palsy and, further, in cases of congenital and traumatic ptosis.

N. BLATT.

Operations

IRIDECTOMY AND INJURY TO THE LENS AND THE PREVENTION OF THE LATTER BY EXTERNAL IRIDECTOMY (IRIDECTOMIA AB EXTERNO). M. SALZMANN, Ztschr. f Augenh. **72**: 127 (Sept.) 1930.

Salzmann presents a careful digest of the literature on iridectomy and a study of the pathologic processes in human eyes in which operative procedures have been employed. He laments the failure of surgeons to report these cases. To avoid the damage to the lens that is so often produced by the classic iridectomy, he proposes an operation that has already been advocated by Elschnig and others, that he has modified somewhat.

He suggests the following procedure: The eye is anesthetized by cocaine and epinephrine, and the muscle of the lid is paralyzed by an injection of procaine hydrochloride into the area of the lateral canthus. Procaine hydrochloride is injected into the insertion in the superior rectus muscle, subconjunctivally and a stay suture is placed there. A conjunctival flap is then made about 6 or 8 mm. above and parallel to the limbus. The flap is then placed downward over the cornea. The incision in the ball is made concentrically in the sulcus sclera externus, with the corneal margin about 1 mm. distant. The lance knife is placed perpendicular to the sclera, and the line of incision, which is usually about 7 mm. in length, is scratched. Then layer after layer is similarly laid open. The fixation is furnished by a stay suture in the superior rectus muscle, which is held by the assistant, and by forceps in the flap, which is held by the operator. A slight downward tug on the flap pro-

duces a gaping of the wound, thus simplifying examination. The scleral wound is deepened so that the transparent cornea can be seen. When bleeding interferes in this procedure, the assistant wipes away the blood with a swab saturated with salt solution. Too much pressure should not be used, for the prolapse of the iris may be pushed away if it appears. It is not well to make the whole incision at one time. Only a small area is opened completely so as to allow the escape of some aqueous and the iris to prolapse. The wound is then opened gradually on either side of the prolapse until about 5 or 6 mm. of the tissue of the iris appears. Salzmann widens the wound with the lance knife, and not with scissors.

If the iris does not appear it is probably because of peripheral synechia. Then it is necessary to break the adhesion of the iris from the corneal attachment with a spatula, as suggested by Elschnig. In cases in which posterior synechiae are present, a tug on the conjunctival flap presents part of the iris, which can then be grasped by the forceps and a peripheral portion excised. The flap is returned to its position, and by a stroke of the wound the pillars of the iris return to the anterior chamber in their respective places. If part of the iris is caught in the wound, a slight manipulation, as a rule, will disentangle the tissue and it will return to its place. Suturing of the wound is unneccessary.

During the operation, little if any bleeding is present, yet within the first twenty-four hours there may be some bleeding due to hyperemia of the tissues. The anterior chamber is restored as in the classic operation. By this method, the lens is never injured. In Salzmann's opinion, external iridectomy performed as he describes it is less difficult than the usual type. The procedure is indicated in any condition in which a simple iridectomy is necessary, and particularly when there is a shallow anterior chamber. If his technic is followed carefully, the instrument need not enter the anterior chamber.

A. M. YUDKIN.

Physiology

THE IRIDOCORNEAL ANGLE: ITS RÔLE IN OCULAR HYDROSTATICS. M. TEULIERES and J. BEAUVIEUX, Arch. d'opht. **47**: 497 (Aug.) 1930.

The assertion by Hamburger that the canal of Schlemm is without function instigated the authors to review the structure and function of the filtration angle. They disagree with Hamburger because they believe his statement to be too exclusive. According to Hamburger, Magitot and Weiss, the aqueous is an inactive fluid which does not escape through the iridocorneal angle and plays no part in the variations of intra-ocular tension which is largely governed by the general, and especially the intra-ocular, blood pressure. Leaving aside the question of the origin of the aqueous, this fluid fills almost the whole of the reservoir of the eye, the vitreous, the anterior and posterior chambers. Whether this liquid mass is inert or plays a part in the dynamics of tension can be determined only by physiologic considerations which the authors state in general terms. Although they admit that Leber, Seidel and their followers have exaggerated the physiologic and physiopathologic importance of the filtration angle, their paper is an attempt to prove that denial of any function to this structure is without basis in

fact. They divide the subsequent discussion into anatomic, physiologic and physiopathologic sections. Under the anatomic considerations, they state the evidence which supports the contention that the region of the angle of the anterior chamber allows the filtration of the aqueous through it. The embryology and structure of the pectinate ligament is discussed. Schlemm's canal, the root of the iris and the episcleral veins are in turn reviewed in the light of more recent work. From a physiologic point of view, the experimental evidence is cited at length, the weight of it favoring the conception that most of the aqueous escapes from the anterior chamber through the filtration angle. Clinical proof of the importance of the iridocorneal angle in the maintenance of intra-ocular tension is cited under the heading of hypertension due to pupillary obstruction, pathologic products in the anterior chambers, congenital absence of the canal of Schlemm, intra-ocular tumors, and many other conditions. This paper constitutes a more or less complete review of this aspect of the problem of glaucoma and should be read in the original.

S. B. MARLOW.

Retina and Optic Nerve

RETINITIS CENTRALIS ACCOMPANIED BY PARESIS OF ACCOMMODATION. Fourth Ann. Rep. Giza Memorial Laboratory, Cairo, pp. 55.

An Egyptian man, aged 38, who was known to have had normal eyes (except for color blindness) a year before, complained of dazzling, followed in six days by a metamorphopsia in the right eye and then a relative central scotoma. Vision was 6/24 unimproved. The anterior segment of the eye, the disk and the vessels were normal. The macular region was slightly elevated and appeared yellowish white and opalescent. Paresis of accommodation was noted eleven days later. The Wassermann reaction was negative.

Under treatment, the vision returned to normal in three months, and the only remaining signs of the macular disturbance were a few yellow spots. The paresis of accommodation remained unimproved.

The condition described is held by the authors to be different from the recurrent central retinitis of von Graefe and from the circumscribed edema of the macula recently described by Weintraub. It is considered, rather, as identical with the cases described in Japan by Asayama, Oguchi, Masudas and Abe.

G. M. BRUCE.

CONSIDERATIONS ON THE TREATMENT OF SPONTANEOUS DETACHMENT OF THE RETINA BY GONIN'S PROCEDURE. JEANDELIZE and BAUDOT, Arch. d'opht. **47**: 764 (Nov.) 1930.

The authors performed operations in fourteen cases of detachment of the retina by thermocautery. They report eight cases in detail, the remaining six being too recent. All of their cases were fairly recent, and in those reported a tear was found. In only two of the fourteen cases did they fail to find a tear. They think that cases without tears become more and more rare as the experience in finding them develops. Sometimes a pocket will have to be opened by puncture before the tear is discovered. In their cases localization was exact five times, within ½ or 1 disk diameter in six. In one case it failed. In two of the cases cited there was complete reattachment; in five, partial reattachment, with,

however, noteworthy improvement in vision. The authors do not think that it is necessary to introduce the cautery into the vitreous in order to produce an adhesive choroiditis. Following cauterization they have frequently noted retinal hemorrhages, but they have not so far been of a serious nature. The period of rest in bed is commonly two weeks, and this they feel is a great advantage. Sourdille's treatment with mercury is discussed, and the authors express themselves as being in favor of its use supplementary to Gonin's operation and as a prophylactic measure.

S. B. MARLOW.

STELLATE PSEUDORETINITIS AND EDEMA OF THE PAPILLA IN INTRACRANIAL HYPERTENSION DUE TO TUMOR. COLRAT, Arch. d'opht. **47**: 773 (Nov.) 1930.

The author presents two cases of intracranial tumor that had typical stellate figures in the macula in addition to bilateral papilledema. These stellate exudates underwent change during observation. In the first case, the exudate disappeared following lumbar puncture, to return more fully developed, with a rise in the intracranial pressure. In the second case, after trephining the figure disappeared but white lines developed along the course of the blood vessels. In his discussion the author refers to cases previously reported and calls attention to the possibility of confusion with albuminuric retinitis. These cases are rare and call for a careful investigation for possible etiology. In the two cases reported the demonstration of intracranial hypertension without signs of renal disease made the diagnosis clear. In cases with signs of renal disease in addition confusion may result if the possibility of tumor is not remembered.

S. B. MARLOW.

Trachoma

TRACHOMA. R. P. WILSON, Fourth Ann. Rep. Giza Mem. Laboratory, 1929, p. 63.

The further progress of inoculated monkeys, detailed in the third Annual Report's appendix no. 3, p. 78 (1928), is reported. Based on the histologic and clinical observations, it is concluded that the natural and experimental condition as seen in these animals is undoubtedly not trachoma, but a simple folliculosis.

The conjunctiva of a blind eye, which had traces of a healed trachomatous infection, was inoculated with the bacillus granulosis. At the end of two months no signs of recurrence of the disease had appeared.

The author is aware of the objection that may be leveled against the choice of such a patient, but it is to be remembered that he has definitely seen cases in which the appearances of trachoma, stage I, have been superimposed on stage IV.

Further attempts to isolate bacillus granulosis from twenty-five cases of Egyptian trachoma have been entirely negative, except that one other strain showing superficial resemblances to the bacillus granulosis has been obtained. Agglutinative reactions were not obtained with the bacillus granulosis.

W. ZENTMAYER.

THE TREATMENT OF TRACHOMA BY INTRAVENOUS INJECTION OF COPPER AMMON SULPHATE. R. P. WILSON, Fourth Ann. Rep. Giza Mem. Laboratory, 1929, p, 86.

A freshly prepared 4 per cent solution of copper ammon sulphate ($CuSo_4H_2O$. 4 NH.) was employed, and the average dose was from 0.5 to 2 cc. (according to age), given intravenously once daily for approximately a fortnight. The results observed were that in the acute cases with marked subjective symptoms there was quick response to treatment, and in those cases in which mercuric oxycyanide was given previously (locally) the improvement already obtained continued. It was found, however, that the injections appeared to have a beneficial effect on the acute signs and symptoms only. The fresh corneal infiltrations were absorbed, and consequently with these, the subjective symptoms were relieved. No definite changes took place in thick pannus, nor was any real improvement noted in the condition of the palpebral conjunctiva.

W. ZENTMAYER.

THE CONTAGION OF TRACHOMA. C. ROCHE, Arch. d'opht. **47**: 680 (Oct.) 1930.

After emphasizing the necessity of reporting cases of trachoma and pointing out how extensive the field of observation is in France, Roche presents the facts as he has observed them in the form of examples. He divides them into four groups. In the first group he cites cases of trachoma in a single individual in a community where trachoma is unknown. In the second, attention is called to the occurrence of isolated cases among poor families living closely together in tenements. The third group concerns cases in which only one eye is involved. In the fourth group he points out that certain persons, such as physicians working in clinics, have daily contact with trachoma over a period of many years without contracting the disease. Thus it seems that under some circumstances trachoma is not contagious, and in others it is indisputably so. Several theories have been suggested which are not entirely satisfactory. Roche expresses the opinion that this disease is contagious only in the earliest stages before the appearance of granulations. He compares this idea with the more recent knowledge as to the contagiousness of scarlet fever, whooping cough and measles. It explains some of the difficulties in the search for the causative agent and some of the irregularities in experimental transmission.

S. B. MARLOW.

Tumors

PRIMARY TUMORS OF THE OPTIC NERVE. G. A. MATHEWSON, Am. J. Ophth. **13**: 880 (Oct.) 1930.

Primary tumors of the optic nerve are classified as: (1) those arising in the nerve, gliomas, which consist of an overdevelopment of the glial tissue; these are the most common; (2) those arising from the meninges of the nerve, meningiomas, and (3) those arising from the fibrous tissue of the nerve sheath, fibromas, which constitute the smallest group. In the main, these tumors are benign and grow slowly. The vision is affected early in cases of glioma, as the fibrils of the nerves are damaged by the overgrowth of neuroglia, whereas in cases of meningioma the nerve is not damaged until the tumor is very large, surrounds the nerve and destroys it by strangulation.

A woman, aged 47, stated that the left eye had begun to protrude five years before examination, and that the sight had failed in this eye two years later. The proptosis measured 2.5 cm.; the movement of the globe was restricted in all directions, and the eye could not be pushed back into the orbit. A Krönlein operation was performed and the tumor removed. The patient made a good recovery, except that complete ptosis resulted. The tumor measured 3.2 by 3 by 2.3 cm. Microscopically, the optic nerve was surrounded by a thin capsule of connective tissue, outside of which was a space caused by shrinkage and then a thick fibrous coat in and about which was the tumor. It was composed of masses of uniform cells with ill defined boundaries and large vesicular nuclei. There was considerable interstitial tissue, and wide bands of collagen separated the masses in places. Many of the masses had a whorl-like arrangement. The arachnoid was involved, but not the pia. Two photomicrographs are shown.

W. S. REESE.

Uvea

VITILIGO OF THE IRIS. DIEGO M. ARGÜELLO, Arch. de oftal. de Buenos Aires **5**: 315 (July-Aug.) 1930.

This is the report of a case of disseminated atrophy of the iris. The nature of this condition was in doubt for a long time. It was first described by Müller from Fuch's clinic as invariably originating from smallpox. The author considers it as differing essentially from cutaneous vitiligo, in which there is no atrophy but only a pigmentary dystrophia, a true dyschromia. Later the author saw another case of vitiligo of the iris.

C. E. FINLAY.

BIOMICROSCOPY OF THE IRIS. SORIA, Arch. de oftal. hispano-am. **30**: 581 (Nov.) 1930.

The author reports his observations of the normal iris, in congenital anomalies, such as heterochromia, nevus and persistent pupillary membrane, in traumatisms, in inflammatory conditions and in glaucoma. With regard to the latter, he has observed a great variety of lesions, from simple emigration of pigment to atrophy of the iris, which occasionally is converted into an exceedingly thin grayish membrane that has lost its function, with a disappearance of the normal elevations and depressions. He finds that the condition of the iris bears no relation to the visual reduction, there being cases with extensive lesions of the iris and relatively good sight, and vice versa. He divides chronic glaucoma into two types: an anterior variety, with an early disintegration of the iris and preservation of good vision till relatively late in the process, and a posterior variety, in which the lesions of the fundus predominate, with a rapid production of blindness. Fistulous operations are more apt to be beneficial in the latter variety than in the anterior type. The emigration of pigment commences at the bottom of the crypts. The author does not think that the diagnostic importance which different authors give to this emigration is justified. In one of his cases, a largely dilated vessel, presumably a vein, was observed on the anterior surface of the iris near the angle of the iris, the like of which he has not seen reported.

C. E. FINLAY.

Vision

THE STEREOSCOPIC ACUITY OF THE ONE-EYED, CONSIDERED FROM THE POINT OF VIEW OF THEIR FITNESS AS AUTOMOBILE DRIVERS. L. WEEKERS AND R. HUBIN, Arch. d'opht. **47**: 657 (Oct.) 1930.

In this report Weekers and Hubin confine themselves to a consideration of the judgment of distance by those blind in one eye. Although the one-eyed have some perception of relief and are able to form judgments of distance by means of parallax movements, accommodation, linear perspective, etc., it is no longer a matter of indifference whether their stereoscopic acuity functions promptly, especially when they are suddenly confronted with a situation that could result in an accident. They describe the apparatus and the method of procedure used in examining a large number of persons. In a group of emmetropes, myopes and hypermetropes the binocular stereoscopic acuity was first measured and then the difference noted when one eye was closed. The one-eyed subjects were divided into two groups according to whether their condition was recent or of long standing. Still another group includes amblyopia ex anopsia. A variation was found from one patient to another. Nevertheless, they were able to conclude that the stereoscopic acuity of the one-eyed is defective even when they have become adjusted to their infirmity over a long period. Except for high hypermetropia, the well corrected ametropias show no influence on the degree of stereoscopic acuity.

S. B. MARLOW.

Visual Tracts and Fields

CENTRAL AND PARACENTRAL HOMONYMOUS HEMIANOPIC SCOTOMAS. O. BARKAN AND H. BARKAN, Am. J. Ophth. **13**: 853 (Oct.) 1930.

The authors review the literature and report two cases. Case 1: A man, aged 65, complained of the glasses prescribed for him; in the course of half an hour, the vision in the left eye became reduced to counting fingers at 6 feet (182.9 cm.). The visual fields showed paracentral, practically congruous, homonymous, hemianopic scotomas, absolute for a 5 mm. white disk and extending within 10 degres of fixation. This region was surrounded by an area of relative defect (absolute for a 5 mm. red disk). There was a quadrant defect for a 2 mm. red disk. At the time the article was written, vision was 10/10 in each eye, but the fields were practically unchanged. There was no longer difficulty of vision or trouble in reading. Case 2: A man, aged 68, with marked cerebral sclerosis, complained of blurred vision. He had had attacks of hazy vision for ten years. These had recently increased in frequency and were accompanied by an unstable feeling and a tendency to lurch to the left (as he believed), though his wife stated that he tended to walk to the right. Vision with glasses was 6/10 in each eye, and Jaeger's test type I was read with difficulty. The fields showed paracentral, homonymous, hemianopic scotomas, practically congruent, and absolute for a 1 mm. white disk on the perimeter. There was a quadrant amblyopia for colors (red 2 and 10 mm.), which included the macular region of both fields. The authors discuss the cases from the standpoint of existing theories as to macular representation in the occipital cortex.

W. S. REESE.

BINASAL HEMIANOPIA. A. LUTZ, Arch. f. Ophth. **125:** 103, 1930.

Three years ago Lutz published an extensive review on binasal hemianopia with some observations on patients of his own. To this first series of eighty-four cases he now adds the description of nine more cases, which only confirms the conclusions made in the previous paper. Most of the patients had few and indefinite symptoms outside the changes in the visual field. Binasal hemianopia should make one think of a tumor in the region of the lateral ventricle or a subtentorial neoplasm if other symptoms of tumor are present. The other etiologic possibilities are syphilis, trauma or vascular lesions.

In the present paper Lutz describes the pupillary symptoms in one case of his own, which support a scheme of the pupillary pathway that he brought out in 1918. Its main features are: Pupillomotor fibers originate in every part of the retina, behave exactly like the corresponding visual fibers in the chiasm and undergo a second partial decussation in front of the third nerve nuclei. It is unnecessary to assume a special path for the macular pupillary fibers. This latter view is based mainly on Roenne's observation in cases of toxic amblyopia with absolute central scotomas in which the light reflex was normal.

P. C. KRONFELD.

Therapeutics

ROENTGEN THERAPY IN TUMORS OF THE AREA OF THE HYPOPHYSIS. F. I. JUSEFOWA, L. I. CZERNY and J. HEINISMANN, Klin. Monatsbl. f. Augenh. **85:** 344 (Sept. 26) 1930.

This is a report of fifty-two cases in which the perimetric examination was given especial consideration in obtaining the diagnosis, or confirmation, of a tumor in the area of the hypophysis. Twelve histories are reported in full. The field of vision was normal in eleven cases, bitemporal hemianopia existed in the same number of patients and temporal hemianopia was found twelve times. Concentric contraction of the field presented in ten cases, homonymous hemianopia in two, and scotoma, as an early and unaccompanied symptom, in two cases, while in two other cases the field could not be taken. Depression of the color fields was found in a number of cases presenting a normal field for white. Absolute and relative scotomas, especially those connected with the macula, proved to be valuable for the diagnosis.

Simple atrophy of the optic nerve and postpapillary degeneration were the most frequent changes in the fundus; choked disk of a moderate degree was occasionally noticed. In one patient the vision of one eye was observed to decrease rapidly, while the other eye remained normal for a long time. The pallor of the disk in progressive atrophy was independent of the gradually failing vision.

Operation was not done in any case; roentgen therapy was used. The best results were obtained in acromegalia where the cerebral and ocular symptoms receded. The acromegalia itself showed no changes, while the growth of the bones ceased. The sexual function returned; polyuria, glycosuria and the symptoms of cranial pressure, vomitus and headache, disappeared. Adiposogenital dystrophia can be influenced. The ophthalmic forms are less amenable. Roentgen rays are considered the most reliable form of treatment at present. In cases of severe cranial pressure a decompression operation is performed, prior to irradiation.

K. L. STOLL.

INTERFERENCE THERAPY (VACCINATION) IN METASTATIC DISEASES OF THE EYE. N. BLATT, Cluj. med. 11: 181 (April 1) 1930.

It is a well known fact that there are cases in which a severe disease assumes a favorable course owing to the intercurrence of a new infectious disease. An explanation of this fact may be derived from the notion of interference; each type of disease, and especially its course, is an example of the principle of interference.

The fate of the diseased system is a function of the interaction of the waves of vitality. If they annihilate one another in the sense of the interference phenomena, it may result in cure. In general practice one must consider the doctrine of interference. In some instances malaria is cured after an attack of erysipelas, syphilis after influenza, epilepsy after scarlet fever, and so on. Within the compass of interference therapy, the experiences gathered at the sickbed in regard to the mutual favorable influence of two coexistent diseases of the system on one another should also be applied to rational therapeutic activity and untilized in practice.

The stimulation therapy of the already routine tuberculin-vaccine treatment also falls within the compass of interference therapy. Malaria therapy, too, acts in the sense of interference therapy.

A second method of the interference therapy is vaccination against smallpox. The therapeutic effect of vaccination can be explained in the sense of such therapy, in that the causative agent of smallpox, the resistant virus, is transferred by inoculation. So by vaccination against smallpox one may apply a method by which the general practitioner can also carry out interference therapy. In metastatic purulent diseases of the eye, a favorable effect may be expected from such therapy.

In severe cases of metastatic processes of the eye, especially purulent keratitis, iridochoroiditis and metastatic iritis, the patients were treated by vaccination against smallpox. In three cases the healing was complete, and in two, interference therapy proved a failure.

N. BLATT.

CHEMOTHERAPY BY MOUTH IN PURULENT DISEASES OF THE EYE. N. BLATT, Orvosi szemle 3: 248, 1930.

It is strange that thus far the taking of antiseptics by mouth has been almost completely supplanted by other methods. For general practitioners, however, this mode of treatment is of particular importance. Any remedy that if given by mouth is apt to reach the more deeply seated cells of the organism and there exert an antiseptic effect may in this respect be considered an important aid. In recent years the author has tried phenylazodiaminopyridine and various preparations of eucalyptus. The action of both of them on various diseases of the eye, especially purulent ones, is satisfactory. Phenylazodiaminopyridine exerts a bactericidal and inhibitory effect on bacteria, particularly cocci, in vivo and in vitro. Since most of the purulent diseases of the eye are caused by cocci, it is easily understood that this drug can display a curative action against them. In ophthalmology, phenylazodiaminopyridine was first tried by the author. Several preparations of eucalyptus were employed, especially eucalyptus oil and eucalyptus tincture. Eucalyptus has long been used therapeutically for purulent processes

in various organs; for purulent processes of the eye, however, it was first introduced by the author. Both preparations are well tolerated if administered by mouth.

Eucalyptus is beneficial in cases of palpebral phlegmon. Four of seven patients treated in this manner were cured without incision, the inflammatory infiltration receding spontaneously. The same beneficial effect was seen in cases of dacryocystitis phlegmonosa, as three of four cases healed without incision. Parenteral treatment (a nonspecific milk preparation) was used along with the treatment with eucalyptus. Cure was also obtained by the same treatment without operative intervention in a case of retrobulbar phlegmon subsequent to ethmoid sinusitis on the left side. This therapy should also be tried in all cases of suppurative diseases of the iris and choroid. In eleven such cases tablets of phenylazodiaminopyridine were given by mouth. The phenylazodiaminopyridine, in addition to the usual therapy, exerted a definitely favorable effect by speeding the cure in three severe cases. In serpent ulcer of the cornea, particularly at the initial stage, eucalyptus ought at all events to be tried, because with it a useful adjuvant has been added to the general practitioner's therapeutic armamentarium. Nine of fifteen cases in which the patients received preparations of eucalyptus at the same time, showed a better healing capacity. Although the therapy for ulcus serpens used up to the present cannot, of course, be superseded by preparations of eucalyptus, it may nevertheless be asserted that these two methods are supplementing one another. Oral chemotherapy with phenylazodiaminopyridine proved beneficial also in one case of gonorrheal ophthalmia. In this case, as well as in four other cases of ulcus serpens corneae, eucalyptus was used at the same time for instillations into the conjunctival sac. Further studies on this point are in progress.

To sum up, it can be said generally that oral chemotherapy with the aforesaid preparations has come to stay as additional therapy for purulent diseases of the eye. It would seem that their effect is brought about via the reticulo-endothelial system.

N. BLATT.

Society Transactions

EDITED BY DR. GEORGE S. DERBY

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

January 15, 1931

H. MAXWELL LANGDON, *Chairman, in the Chair*

GLASS SPHERE IN ORBIT. DR. GEORGE H. CROSS.

A man, aged 54, had been referred for reconstruction of the left socket, which was so shrunken and cicatrized that it was no longer possible to wear an artificial eye. At examination a solid object was found deep in the orbit. On questioning, the patient stated that thirty-four years before, following the loss of his eye, a Mule's operation had been performed. In order to enlarge the socket at this time, an incision was made through the tissues of the orbit and a hollow glass sphere about 13 mm. in diameter was removed. Strangely, this sphere was filled with a slightly turbid bloody fluid which had evidently seeped through a pinhole opening. Where the fluid came from was an unsolved problem. During the thirty-four years that this glass ball had been in situ there was gradual absorption of the glass, leaving a very thin spot which had evidently broken through. It was thought that the case would be of interest in relation to the newer operations used in enucleation.

PENETRATING WOUND OF LOWER LID AND EYEBALL. DR. FREDERICK KRAUSS.

A man was struck with a large piece of glass from an exploding root beer bottle which he had placed near a stove. The cut extended nearly the whole length of the lower lid. The cut in the eyeball began about 5 mm. below the ciliary body at about 6 o'clock and extended about 12 mm. down and back. The eyeball was very soft. Vision was nil. The vitreous was filled with blood; therefore, no view of the eye-ground was obtainable although the anterior media remained clear. After the wounds were sutured, the patient was given atropine and a solution of metaphen for antisepsis. After ten days the vitreous began to clear. A Vossius ring was present. Through the retina a broad white tear could be seen in the periphery extending halfway to, but lateral to, the macula. The retinal edges of the cut were blood-stained throughout. The vitreous cleared except for a dense organized mass below and very far anterior. The cut in the retina apparently healed and at present is seen with difficulty. The field of vision is but slightly cut. With a correcting lens, central vision is 20/30. Externally, there is a slightly depressed pigmented scar in the sclera at the site of the injury. The Vossius ring, though less marked, has persisted.

DISCUSSION

DR. W. ZENTMAYER: The discusser asked if the Vossius ring had been examined with the biomicroscope for the purpose of determining

whether the lesion was pigment or blood, a question which is still in dispute. He cited an experience that he had some years before while doing an advancement operation. As he placed one of the scleral sutures, he was conscious of the sudden change in resistance and thought that the needle had probably gone through the sclera. Shortly afterward a line of blood appeared on the anterior surface of the iris, just sufficient to obscure vision. Two days after the operation, he examined the eye with the ophthalmoscope and found that the patient had a typical Vossius ring cataract. Dr. Holloway confirmed the diagnosis. This patient had been under observation for some time in the clinic and had been refracted several times. The media had always been noted as clear. Hesse endeavored to produce a Vossius ring cataract by injecting a small amount of blood into the anterior chamber but because of the rapid coagulation of the blood, he was successful in only one instance. After learning of Dr. Zentmayer's experience, Finnoff undertook to cause this lesion experimentally by producing an intra-ocular hemorrhage. He produced a partial ring in one case. He expressed the belief, however, that rabbits were not altogether suitable for the experiment.

Dr. F. Krauss: The discusser said that the anterior chamber had always been free from blood. Under the slit-lamp very fine punctate opacities were seen which he had interpreted as pigment rather than blood.

Homonymous Hemianopia in Diabetes. Dr. G. de Schweinitz.

The cases of five patients (two men and three women) with diabetes and homonymous lateral hemianopia were reported. Reference was made to eighteen other cases in the literature, and especially to those collected by Wilbrand and Saenger. It was pointed out that this defect in the field was not due directly to the diabetes, but was caused by vascular lesions in the occipital lobes. Right or left lateral hemianopia may be complete at once; it may begin as a quadrant defect followed later by loss of the homonymous lateral fields, or with scotomas which subsequently expand into complete hemianopia; lateral homonymous scotomas remain unchanged.

In one case reported by Wilbrand, the defect in the field presented itself in the form of so-called macular hemianopia. Occasionally the hemianopic defect entirely disappears; usually it is permanent. It may be detectable only if the field is tested under reduced illumination, especially if partial cataract is present. The hemianopia may be the only symptom of the lesion of the brain, or it may be followed by others, for instance, hemiplegia. In all cases that have come to autopsy, as reported in the literature, the lesions were vascular (hemorrhagic).

DISCUSSION

Dr. T. B. Holloway: The discusser was delighted that Dr. de Schweinitz had brought this subject before the Section. He said that it was quite true that hemianopia associated with diabetes was not mentioned in connection with this disease in many of the treatises concerning this subject. He had seen but two instances, one at the University Hospital many years ago, and the second in private practice. He felt, as he knew Dr. de Schweinitz did, that the condition was the result of vascular changes so frequently seen in connection with this disease.

CYSTS OF THE ORBIT. DR. FREDERICK KRAUSS.

Two cases of cyst of the orbit were presented. The first case was in a woman, aged 76, who presented a dense tumor in the upper inner angle of the orbit. It was slow in growth and not associated with pain. Careful palpation indicated a soft center. Roentgenograms were negative. Nasal symptoms were absent. On dissection, the tumor was found to be filled with very thick mucoid substance, culture of which showed staphylococci only. A second collection of the same material was found in the deeper ethmoidal cells when the curet was carried through a small carious opening in the os planum. The periosteum had been elevated by the secretion to make a cavity extending close to the entrance of the optic nerve. After a large opening had been made into the nose, with primary closure of the wound, rapid healing occurred.

In the second case, the tumor was associated with edema of the lids and considerable proptosis of the left eyeball. Roentgenograms disclosed disease of the frontal, ethmoid and antral sinuses of that side. The middle turbinate did not appear diseased, but the outer nasal wall was slightly edematous and pressed on the turbinate. An intranasal operation was performed with the evacuation of large quantities of an offensive pus from the ethmofrontal region. Complete exenteration of the ethmoids was performed with washing of the antrum, which also contained offensive mucopus. The external operation was not performed as the condition improved with complete disappearance of the exophthalmos.

THE TREATMENT FOR INTERSTITIAL KERATITIS. DR. JOSEPH V. KLAUDER AND (by invitation) DR. HAROLD F. ROBERTSON.

An analysis of 105 cases of interstitial keratitis (females, sixty-three; males, forty-two) was made with reference to the following: age of patient: up to 5 years of age, six patients; from 6 to 10 years, twenty-four; from 11 to 15, twenty-nine; from 16 to 20, twenty-one; from 21 to 25, fifteen; from 26 to 30, eight; from 31 to 35, one; from 35 to 40, one. The absence or presence of the major stigmas of congenital syphilis concern facies: present in thirty-nine, absent in thirty-seven, suggestive in six and not mentioned in twenty-three; teeth: hutchinsonian in sixteen, abnormal in thirty-five and normal in fifty-four; deafness: present in four and absent in the others; saber tibia: present in twenty, suspected in six, absent in sixty-two and not mentioned in seventeen; Clutton's joints: present in eighteen; suspected in nine and absent in seventy-eight; Wassermann and Meinicke reactions: positive in all but four cases. (Thus about one third or less of the entire series presented objective evidence of congenital syphilis, whereas all but four patients presented positive Wassermann reactions; in two of these four the Meinicke reaction was positive.) Involvement of the eyes: active involvement in both eyes in thirty-five; unilateral involvement in thirty-seven; an inactive condition in thirty-three. Period of observation: about one third of the patients attended the clinic for about six months; one third for about one year, and one third from one year to thirty-four months. Results of treatment: of thirty-seven patients with an initial attack of interstitial keratitis in one eye,

there was an involvement of the second eye in ten. In three of these, however, this involvement occurred after very little treatment and then a lapse of all treatment, owing to lack of attendance; in five, after moderate treatment and then a lapse of all treatment; in two cases involvement of the second eye occurred after thorough treatment. In the entire series, recurrence occurred in one or both eyes in three patients after a moderate amount of treatment. Treatment: the following drugs were employed: neoarsphenamine, sulpharsphenamine (intramuscularly and intravenously), tryparsamide, unctions of mercury, iodides (orally and intravenously), bismuth (intravenously and intramuscularly) and bismarsen (an arsenical bismuth preparation). One or more of these drugs were employed in different patients in order to determine the most effective means of treatment for interstitial keratitis. Of the foregoing drugs, bismuth appeared to yield more favorable results than any of the other drugs. Moreover, bismuth is much less toxic than mercury or arsenic. It is well tolerated by children, and its administration is much more practical than that of the arsenicals. The importance of early diagnosis and early treatment were emphasized. It was advocated that an injection of bismuth be given the first day the patient is seen, even though the diagnosis is not definitely established, since such an injection is harmless. The more favorable formula of treatment appeared to be a weekly injection of bismuth intravenously (10 mg. of colloidal bismuth), a weekly injection of bismuth intramuscularly and from 15 to 25 grains (0.97 to 1.62 Gm.) of sodium iodide (depending on the patient's age). The dosage of bismuth for intramuscular injections advised at different ages is: 25 mg. of the metal bismuth, up to the age of 5 years; 50 mg., from 5 to 6 years; 75 mg. from 6 to 7½ years; 100 mg., from 7½ to 10 years; 150 mg., from 10 to 14 years, and 200 mg., over 14 years.

Lantern slides were used, showing the evolution of interstitial keratitis, with and without treatment, and unusual features of the disease. The phenomenon of involvement of the other eye was discussed. It was pointed out that such involvement, while the patient is receiving treatment, is unique in the entire field of syphilology. There is only one other clinical circumstance in which a comparable process occurs, and that is rare: the occurrence of cutaneous syphilids while antisyphilitic therapy is being administered. In these circumstances the administration of another antisyphilitic drug (changing from an arsenical to mercury or bismuth) invariably causes involution of the cutaneous syphilid. The rôle of anaphylaxis in sensitization of the uninvolved eye was discussed. The possibility of antisyphilitic drugs not reaching the cornea was also discussed. Recent studies by others, however, show that some drugs do reach the cornea. Experimental studies are being conducted to determine if antisyphilitic drugs injected into rabbits reach the cornea.

Syphilis was visualized as an infection from a clinical and laboratory point of view. It was pointed out that the mechanism of immunity in syphilis is largely a tissue rather than a humoral reaction. In experimental syphilis in rabbits, the incidence of ocular lesions can be varied by using experimental means to vary general tissue reactions. It appears from the foregoing visualization that the cornea responds feebly to a syphilitic process.

Unsuspected Brawny Scleritis in a Case of Retinal Detachment with Secondary Glaucoma. Dr. T. B. Holloway and (by invitation) Dr. W. E. Fry.

A man, aged 49, had been having exacerbations of pain and redness of the left eye for six months. There was no history of injuries or previous inflammatory attacks. The Wassermann reaction of the blood was positive. Vision was 5/5 in the right eye and perception of light in the left. The right eye was normal. In the left eye the pupil was dilated and fixed. There was a diffuse bulbar injection with marked overfilling of the episcleral vessels. The cornea was clear and the anterior chamber shallow. By oblique illumination an enormous detachment of the retina was readily discerned. By transillumination a questionable shadow was observed centrally in the pupillary area, but it was not regarded as dependent on a growth. With the Schiötz tonometer the tension of the right eye was 16 and that of the left, 33. Microscopic examination showed the characteristic findings of brawny scleritis. Dr. Verhoeff examined the sections and reported that he believed the condition to be as described.

Dr. Holloway stated that this patient had been sent to his office for consultation. From the scant perception of light, the detachment of the retina and the secondary glaucoma, he felt that there was but one decision to make, despite the fact that no definite shadow, dependent on a probable growth, was present. A brawny scleritis was not even thought of at the time the patient was seen, and the eye did not manifest any evidence of the clinical findings usually associated with this disease. The literature showed several instances in which the condition was unsuspected and the diagnosis made after enucleation.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

H. Dickinson, Reporter

Annual Congress, April 23, 24 and 25, 1931

Mr. Leslie Paton, F.R.C.S., *in the Chair*

All the meetings were well attended, and in association with the Congress an exhibition of ophthalmologic apparatus was held in which leading firms participated. Sir Almroth Wright gave an address on vaccine therapy. On the first evening, members and guests dined together.

Abstracts of some of the twenty-six contributions are presented.

An Analysis of One Hundred Cases of Retinal Detachment Treated by Cautery Puncture. Mr. C. Shapland.

In cautery puncture, which was Gonin's method, it was assumed that there was a hole in the retina, and an attempt was made to occlude it. In thirty-four cases seen during the same period either no hole was found and a cautery puncture was carried out in the old way over the most prominent part of the detachment, or the detachment was regarded

as of too long standing, the rent as too extensive or the age as too great to justify operation. Fifty-six of the hundred patients were males and forty-four females; their average age was 41½ years. Refractively, the cases fell into four groups: (1) high myopia, (2) low myopia, (3) aphagia and (4) emmetropia. Trauma, local or general, apparently played a part etiologically in a small proportion of the cases of myopic detachment and in a larger proportion of the emmetropic group. Of the fifty-six myopic patients, nine gave a history of a blow on either the affected eye or an adjacent part of the head just before the onset of the visual defect for which advice was sought. Two had had recent heavy falls; while in one, who suffered from bronchitis, the straining during the severe cough seemed to have been an exciting factor. In the emmetropic group of forty-one patients, sixteen gave a history of recent local injury and one of general trauma.

Retinal holes could be roughly classed into five groups: (1) festoon-shaped holes situated at the extreme periphery, corresponding to Gonin's "disinsertion" at the ora serrata; (2) holes that were rounded as though punched out; (3) arrowhead and horseshoe-shaped rents, the head of the arrow being on the side next the disk; (4) radial slitlike tears, and (5) irregular rents. By far the commonest site for a retinal hole was the periphery of the temporal half of the globe. In this series 54 per cent of the retinal disinsertions at the ora occurred in the inferotemporal quadrant of the globe; 73 per cent in its lower half. The rounded hole showed a tendency to be multiple, eleven of the cases in this group presenting more than one hole; the maximum number of holes was six. The diameter of the holes varied from less than 0.1 mm. to at least the size of the disk itself; while their average distance from the ora serrata was 2 disk diameters. In this series 50 per cent occurred in the supero-temporal quadrant of the globe. The arrowhead-like ones occurred in the temporosuperior quadrant eleven times, and superonasally seven times. This type of rent tended to be large, and usually required more than one cautery puncture to seal it. When it occurred, the upper half of the globe was involved in 83 per cent of the cases; in none was this type of rent multiple. The arrowhead-shaped kind showed the greatest incidence among the patients with a high degree of myopia.

Of the one hundred patients, forty were discharged from the hospital cured, and seventeen showed improvement either in visual acuity or in the visual field. Patients were regarded as cured in whom the retina had become reattached and the field was full when they left the hospital. Twenty-one of the cured patients were females and nineteen males. The average age of the cured patients was 34½ years. The average duration of the detachment from the time the visual symptoms started until their admission to the hospital was seven weeks. The longest period before a successful result was obtained was twelve months, the shortest seven days. No successes were achieved in the aphakic group of cases. Among the successful cases were eighteen of retinal disinsertion, sixteen of the round hole and six of the arrowhead-shaped rent. There were no radial slitlike tears or irregular rents in the cured cases. Of the forty primarily successful cases, detachment recurred in eleven, and this was after an interval that varied from a week to eight months. The reattachment occurred in three of the emmetropes, in three patients with a low degree of myopia and in five of those with a high degree of myopia.

DISCUSSION

MR. FRANK JULER: Some patients with detachment were treated by the Gonin procedure. (Mr. Juler had had 32 per cent of cures.) In a man, aged 50, vision before operation was reduced to perception of hand movements on the temporal side. After applications of the Paquelin cautery both field and vision were improved at once. The retina was in place up and in, but was still detached below; another small hole was detected in this area. Eight and a half months after operation the retina was in place throughout, and the visual field was full. In another case, a man aged 27 had bilateral detachment of old standing. Operation resulted in a vision of 6/24 in the right eye and 6/5 in the left; the fields were full and the retina firmly fixed.

TREATMENT FOR CHRONIC BLEPHARITIS WITH VACCINE. MR. M. M. S. MAYOU.

The condition varies in severity from cases of slight blepharitis to those in which there is destruction of the lid margin, hair follicles, glands, etc., and thickening due to chronic inflammation of the lid. This contribution was particularly concerned with the more chronic type that are usually called pustular or ulcerative blepharitis, giving rise to trichiasis and tylosis, with eversion of the puncta and ectropion. Infection of the conjunctiva was always present in the cases observed. In early stages it took the form of recurrent attacks of inflammation, but later became chronic. Sooner or later these cases showed infection with the Morax-Axenfeld bacillus, which caused a thickening of the conjunctiva, and there was usually an associated eczema of the face and head. It was important first to clear up any source of septic infection, such as septic tonsils and discharging ears; then to give the patient healthy surroundings, with the appropriate sunlight and tonic treatment. Injecting vaccine into the arm in these cases was practically useless, but the results at the White Oak Ophthalmia Hospital at Swanley had been much improved by injecting into the eyelid a vaccine of mixed staphylococcus and Morax-Axenfeld bacillus, in a strength of 500 million per cubic centimeter of each of those organisms. Patients who did not respond to this were given injections of an autogenous vaccine, with good results. The patients had been given a vaccine of a strength of 1,000 million of each organism, divided between the two upper and lower lids, without an undue reaction. The treatment was given once a fortnight until the disease cleared up. Patches of eczema had cleared up following injection of the vaccine beneath them.

THE NONSYPHILITIC ARGYLL ROBERTSON PUPIL. MR. R. FOSTER MOORE.

This paper was supplementary to one contributed in 1924, and included a number of additional instances. Twelve of the fifteen patients were females, showing that it was more common in that sex than in the male. As a number of cases were discovered by accident, the age incidence could not be stated definitely. Some might have been of congenital origin. The age of onset given by patients and relatives varied from 7 to 42 years. In fourteen cases the fundi were

examined with the aid of a mydriatic, but none showed any important abnormality. Visual acuity could be said to be unaffected, as it was 6/6 in fourteen cases. In most cases only one pupil was affected. These pupils were semidilated, and they were practically inactive to the light stimulus, whether direct or consensual. They contracted with convergence, but the rate of contraction varied greatly, as also did the degree of completeness of the contraction. Relaxation was slow. Accommodation was not paralyzed. It was clearly important to discover whether the condition bore any relation to syphilis. This had not been discovered in any of these cases. There was practically no sign of nervous disorder. The condition did not seem to be related to any constitutional disorder.

THE NATURE AND ANTIQUITY OF STEREOPSIS. MR. CHAVASSE.

If squint is due to a defect of the fusion faculty, lameness can be said to be due to a defect of the walking faculty. Reactions and not sensations are observable. (A classification of visual reaction from protoptic to stereoptic was given.) Stereoptic reactions of a grade above the lowest are observable in ordinary fishes, but the lowest grade is probably not represented in any surviving species. Therefore, concomitant convergent squint, so far from being a failure to acquire the latest evolutionary accomplishment, appears to be due to the frustration of an activity almost as old as the vertebrate.

HEREDITARY ASPECTS OF LEBER'S OPTIC ATROPHY. DR. RITCHIE RUSSELL (Edinburgh).

This disease does not seem uniformly to follow the rules of inheritance of a single recessive character. In Leber's disease an affected male rarely has affected grandsons. The mode of inheritance is not the same in the various sex-linked diseases, and in some strains at least an accessory factor is concerned in their development. (Dr. Russell's paper dealt with four cases in the same generation in a family living in the Orkneys. The following was a typical example.) A man, aged 40, had loss of vision and pains in the legs. At first there was only slight dimness of vision after reading; this did not interfere with his work as a carpenter. Later he had severe pains in the right eye, which lasted a week, and with these pains vision failed rapidly in both eyes. Coincidently he had pains in both feet, which became swollen. Vision had improved but little. He had five healthy children. The higher cerebral functions were apparently undisturbed. Both the disks were bluish gray; the edges were sharply outlined, and the lamina cribosa was prominent. No changes were apparent in the maculae or in the periphery of the retinas. The pupils were 4 mm. in diameter, circular, equal and regular in outline. Ocular movements were full in all directions. Neither nystagmus nor diplopia was present, but the patient could not converge. No disturbance of muscle power, tone or coordination was noted; neither was there any abnormality of pain sensation or appreciation of passive movement. Three cases in the same generation followed a consanguineous mating. Perhaps a second factor, not sex-linked, and multiplied by the consanguinity, was concerned in the manifestation of the disease. Dr. Russell did not think this likely, but the consanguinity might have reduced the general vigor of the stock

and so caused a dormant trait to become manifest again. Leber's disease shows no evidence of its presence until years after birth and in this it stands alone in this group of diseases.

OCULAR SYMPTOMS IN OSTEITIS DEFORMANS. MR. A. W. ORMOND.

The case described was reported by Dr. Herbert French in 1920, and eight years later Mr. Ormond saw the patient because of the ocular condition. The first complaint had been that of pains in the right tibia, followed by pain and aching in all bones. A curvature of the radius was noted, and at a later stage there was pain in the bones of the head. The patient had not had typhoid or lived abroad; he had no history of syphilis, and was an abstainer and nonsmoker. Early in the illness he complained of a flickering to the right in the eyes, and he tended to move to the right instead of straight ahead. Vision in the left eye was defective. On examination by the author there were definite pathologic changes in the fundus of the left eye involving the macular area. Vision of the right eye at that time was 6/6, but that of the left was less than 6/60, and there was only peripheral vision. A large choroidal hemorrhage was seen, with much disturbance of retinal pigment. Later there was considerable failure of vision in the right eye, and changes similar to those in the left, the visual acuity being no more than 6/36. This year the patient could not see 6/60 with either eye, and central vision was depressed. In the right eye there was a large mass of organizing tissue in the macular area. In this region there was also a scattered patch of what was probably old hemorrhage pigment. The left macular region was occupied by an atrophic area, with sclerosed and tortuous choroidal vessels; the arteries were small and attenuated. There were gross changes surrounding the optic disk. The hearing power was lessening. The ocular defects that had been reported in association with Paget's disease were due to two separate conditions: (1) changes caused by the optic foramen pressing on the nerve and leading to changes in the fields of vision, with loss of visual acuity and the production of optic atrophy; (2) definite retinal and choroidal disturbance with hemorrhage as the result of widespread vascular changes not affecting the nerve head. Many observers have found in the eyes of patients suffering from osteitis deformans a condition similar to that found in advanced disease consequent on inherited syphilis. Some have thought the disorder one of the perverted metabolic type. In one recorded case marked improvement followed a change from a partially carbohydrate to an almost exclusively protein diet. With the diagnostic aid of improved roentgenography the disease does not appear to be as rare as was formerly supposed. Most persons thought that a toxin of some chemical deficiency, acting through the blood stream and affecting the vascular system generally, was the cause. Most cases of long standing had some evidence of vascular changes, both in the fundus oculi and in the body generally.

PAPILLEDEMA. MR. EUGENE WOLFF (in collaboration with MR. FRANCIS DAVIES).

Mr. Wolff read a report of work carried out in the anatomy department of University College, London, on the pathology of

papilledema. The conclusions arrived at were: 1. Nondiffusible dyes injected into the cranial subarachnoid space at pressures compatible with life do not enter the optic nerve. 2. Claims to have produced papilledema by injecting fluids into the subarachnoid space at pressures compatible with life were not upheld by this study. Structural reasons were advanced for the special site of commencement of papilledema in human beings, and for the extent of the distribution of the edematous fluid associated with papilledema.

INTRACAPSULAR CATARACT EXTRACTION. DR. A. H. H. SINCLAIR.

Dr. Sinclair showed a cinematograph film of his present mode of performing intracapsular cataract extraction. He pointed out that the safety of this proceeding had been greatly enhanced by the universal employment of akinesia of the orbicularis by the retro-ocular injection of procaine hydrochloride and epinephrine, and by the laying in readiness of a conjunctiva suture prior to making the incision.

The concluding function of the Congress was an interesting visit to the National Institute for Medical Research at Hampstead, London.

Book Reviews

CLINICAL ALLERGY, PARTICULARLY ASTHMA AND HAY FEVER, MECHANISM AND TREATMENT. By FRANCIS M. RACKEMANN, M.D., BOSTON. Foreword by PROF. HANS ZINSSER. Price, $10.50. Pp. 617. New York: The Macmillan Company, 1931.

This book brings up to date the knowledge of a subject that is one of the most important in medicine today. In the past, the practical knowledge of allergy has suffered from the fact that the average clinician was not familiar with the immunologic principles involved, and the immunologist was isolated in a laboratory. These difficulties have been overcome in this volume, as the author, through his personal work, was able to combine the two. In past years, there has not been the collaboration between these two divisions of the subject, with the consequence that the average physician has had an imperfect or hazy idea of the whole subject, a subject at the best of times difficult to understand. As Dr. Hans Zinsser says in an excellent foreword to this volume, a few years ago the worker in immunology was regarded as a specialist so far removed from the field of practical medicine that his inclusion in the medical school and hospital was looked on as a luxury. From the other standpoint, too, the practicing physician was expected to know no more about immunology than he needed to know about organic chemistry, in order to prescribe drugs. This lack of coordination has been suffered from generally, but happily it is a thing of the past.

The book is a well written, up-to-date exposition of the subject of allergy in all its branches. From the history of the subject to the latest methods of diagnosis and treatment, the whole is complete and exhaustively dealt with, and the clinical part is illustrated with types of cases of every imaginable kind.

The author reveals his mastery of a difficult—an admittedly difficult—subject and is content to lay before the reader his experimental and clinical experiences in an unbiased way. These experiences, by the way, are extensive.

A perusal of the volume will place before the reader the whole subject of allergy in a readily understandable form. The volume has the decided advantage that it gives the whole subject in such a form that the busy clinician will no longer feel that he is at a disadvantage on account of his lack of knowledge of immunologic problems.

The question of anaphylaxis in man and animals, the chemistry and the immunologic and desensitization phenomena are dealt with at length. The diagnosis in various types is given in detail. From the clinical standpoint, the whole question of asthma, hay-fever, vasomotor rhinitis, etc., is dealt with extensively, as is also the relationship between sensitization and eczema, angioneurotic edema, migraine, conjunctivitis, etc.

In the opinion of the reviewer, this volume is practically a textbook on the subject of allergy, which is attractively written, with a wealth of detail. It will serve as a guide to the immunologist and clinician and bridges a gap that has long been apparent to those interested in the subject.

J. G. DWYER.

BULLETIN OF THE OPHTHALMOLOGICAL SOCIETY OF EGYPT. Volume 23. Pp. 76. Cairo, Egypt: Misr Press, 1930.

This publication, which is written partly in French and partly in English, is made up largely of communications brought before the Ophthalmological Society of Egypt at its twenty-seventh session. It begins with the opening address of the president, Dr. Sobhy Bey.

In the first paper, Peretz deals with the difficulties encountered in operating for cataract in Egypt and contributes nothing of note. Most of the difficulties enumerated are not indigenous to Egypt.

A new operation for trichiasis is then described by G. Salvati in an obscurely worded article. The illustrations are incredibly bad.

M. A. Barrada suggests a substitute for the speculum in operations for cataract. Sutures are introduced through the margins of the lid, which are held open by traction on the threads. The author seems unaware of the fact that this procedure is at least thirty years old.

Two cases of interstitial trachomatous keratitis are reported by Meyerhof. He feels that such cases are strictly trachomatous in origin, although he states that "serological or other evidence of syphilis may or may not be present."

An article on trachomatous pannus by El-Kattan contains some excellent photomicrographs.

The next contributor, under the delusion that phenolaine and phenol are similar substances, injected a solution of the latter under the conjunctiva in a case of corneal opacity. The patient had a stormy convalescence, but the cornea finally became clearer. "The effect," says the author, "was marvelous."

Another writer announces that conjunctivitis may attack persons who frequent beaches.

Following this are a well illustrated case report on caterpillar hair in the cornea and a trivial article on hole in the macula, by El-Maghraby.

The final contribution is a report on the work carried out by F. Massoud, under the auspices of the Giza Memorial Laboratory. It is entitled "The Differential Blood Count in Relation to Diseases of the Eye." Four hundred patients who were suffering from many ocular conditions were examined; from two to fifteen counts were made in each case. The author concludes that a high mononuclear count indicates the presence of a particular toxin which is acting on the reticuloendothelial tissue. It follows that in the presence of such a toxin the trauma of an operation may start an inflammatory process in an apparently healthy eye. While the investigator has performed a laborious task well, he has failed to justify his conclusions. However, he has made an important suggestion, and it is hoped that further investigation will enable him to prove his case.

G. M. BRUCE.

MEDICAL RESEARCH COUNCIL. REPORTS OF THE COMMITTEE UPON THE PHYSIOLOGY OF VISION. VII. A RE-DETERMINATION OF THE TRICHROMATIC MIXTURE DATA. By W. D. WRIGHT. Price: 1 shilling, 3 pence, net. Pp. 38, with 12 illustrations. London: His Majesty's Stationery Office, 1929.

From the time of Newton, attempts have been made to mix the spectral colors. About seventy years ago, Maxwell devised a method

of separating them and plotted a curve around an equilateral triangle, at the apexes of which were the three primaries, red, green and blue. From this he obtained color equations and was able to express numerically the proportions of the primaries in all spectral colors.

Since his time many observers, beginning with Helmholtz and later Abney and Koenig, especially the latter, have obtained more accurate results with improved methods. All were handicapped by inadequate apparatus. Several colorimeters, made by Zeiss and others, are obtainable, but the author had one constructed which is far in advance of all others because of its perfect selectivity and its practically complete elimination of all stray light. Another marked improvement is the purity of his white light. This was obtained with a 1,000 watt lamp, the light from which, filtered through a copper sulphate and cobalt sulphate solution, fell on a white magnesium oxide screen.

The author describes a new method of representing a color graphically. If two of three coefficients are known, the third is given by the difference from unity of the sum of these two. Hence, rectangular axes and ordinary graph paper may be used. Thus, if the abscissa of a point gives its red, and the ordinate its green, coefficient, these completely determine the color represented by the point.

In view of the complexity of the physiologic mechanism involved, the author indicates the need of further research.

Colorimetry, especially in the industrial arts, is now so important that the value of this author's work cannot be overestimated.

JOHN B. LYNCH.

Directory of Ophthalmologic Societies *

FOREIGN

British Medical Association, Section on Ophthalmology

President: Mr. E. E. Maddox, Glenartney, Poole Road, Bournemouth, England.
Place: Eastbourne. Time: July 22-24, 1931.

Oxford Ophthalmological Congress

Master: Dr. A. B. Cridland, Salisbury House, Chapel Ash, Wolverhampton, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 8-11, 1931.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 Avenue de La Motte Picquet, Paris 7è.

NATIONAL

American Medical Association, Section on Ophthalmology

Chairman: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Parker Heath, 1551 Woodward Ave., Detroit.
Place: New Orleans. Time: 1932.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. F. Barnhill, Miami Beach, Fla.
President-Elect: Dr. S. Hanford McKee, 1528 Crescent St., Montreal, Canada.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: French Lick, Indiana. Time: Sept. 14-19, 1931.

American Ophthalmological Society

President: Dr. Arnold Knapp, 10 E. 54th St., New York.
Secretary: Dr. Emory Hill, Professional Bldg., Richmond, Va.

SECTIONAL

New England Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Me.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. Chester H. Bowers, 1136 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Albert E. Hillis, 1115 Pacific Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. Claude T. Uren, City National Bank Bldg., Omaha.
Secretary-Treasurer: Dr. Frederick H. Roost, 420 Trimble Bldg., Sioux City, Iowa.
Place: Fontanelle Hotel, Omaha. Time: November, 1931.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Fletcher D. Woodward, Box 162, University, Va.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: New Orleans. Time: November, 1931.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Wilfrid Haughey, 65 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. H. Fraser, Battle Creek Sanitarium, Battle Creek.
Time: Third Thursday of alternate months.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Ralph W. Danielson, 258 Metropolitan Bldg., Denver.
Place: First floor, Metropolitan Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive. Annual meeting in Denver, July 25, 1931.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Dorland Smith, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: W. L. McDougall, 50 Whitehall St., S. W., Atlanta.
Secretary-Treasurer: Dr. William O. Martin, Jr., 412 Medical Arts Bldg., Atlanta.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John W. Carmack, 23 E. Ohio St., Indianapolis.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Gordon F. Harkness, 215 Main St., Davenport.
Secretary-Treasurer: Dr. W. F. Boiler, 105 E. Iowa Ave., Iowa City.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John C. Brown, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Hendrie W. Grant, Lowry Bldg., St. Paul.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. L. H. Huber, Livingston.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. B. Beeson, 232 W. De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. M. Hendershott, 193, 11th St., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.

Rhode Island Ophthalmological and Otological Society

President: Dr. Raymond F. Hacking, 105 Waterman St., Providence.
Secretary: Dr. Herman A. Winkler, 224 Thayer St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

Utah Ophthalmological Society

President: Dr. Franklin H. Raley, 9 Exchange Pl., Salt Lake City.
Secretary-Treasurer: Dr. H. Leroy Smith, 1005 Medical Arts Bldg., Salt Lake City.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Fletcher D. Woodward, Box 162, University.
Secretary-Treasurer: Dr. Henry Grant Preston, Harrisonburg.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. S. S. Hall, Fairmont.
Secretary: Dr. G. A. Smith, Montgomery.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

Chairman: Dr. J. Wallace Hurff, 86 Washington St., Newark.
Secretary: Dr. Earl LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

Academy of Medicine of Toronto, Section of Ophthalmology

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W., Toronto.
Time: First Monday of winter months.

Atlanta Academy of Ophthalmology and Oto-Laryngology

President: Dr. John R. Childs, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society. Section on Ophthalmology

Chairman: Dr. Angus Lloyd MacLean, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John N. Evans, 23 Schermerhorn St., Brooklyn.
Secretary: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday of February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. A. F. Luhr, 40 W. North Ave., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. William V. Mullin, 9204 Euclid Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 2064 E. 9th St., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. W. E. Burner, Guardian Bldg., Cleveland.
Secretary: Dr. M. P. Motto, Rose Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Maxwell Langdon, 1530 Locust St., Philadephia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. A. M. Hauer, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Albert D. Frost, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. M. Sellers, 717 Pacific Ave., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, 717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. G. G. Marshall, 122 West St. Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday of October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. J. J. Richardson, 606 Penn St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Needham, 1304 Medical Arts Bldg., Forth Worth, Texas.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Claude C. Cody, 1306 Walker Ave., Houston, Texas.
Secretary: Dr. J. M. Robison, Eye, Ear, Nose and Throat Hospital, Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. E. L. Lingeman, 241 N. Pennsylvania St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Secretary: Dr. O. S. Gilliland, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dean E. Godwin, Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Ferris Arnold, Security Bldg., Long Beach, Calif.
Place: Pacific Coast Club. Time: Last Wednesday of each month from September to June.

LOS ANGELES COUNTY MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Eugene R. Lewis, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 727 W. 7th St., Los Angeles.
Place: California Lutheran Hospital, Assembly Room. Time: 8 p. m., first Monday of each month from October to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Dr. James A. Flynn, 1511 Rhode Island Ave., Washington.
Secretary: Dr. E. R. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Herbert F. Wolters, 130 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. W. R. Buffington, 211 Camp St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Algernon B. Reese, 50 W. 52nd St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. George B. Potter, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. J. C. Davis, 425 Aquila Court, Omaha.
Place: Medical Tea Room. Time: 5:15 and 7:00 p. m., third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. Clyde Heatly, 11 N. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. John F. Gipner, 53 S. Fitzhugh St., Rochester, N. Y.
Place: Rochester Medical Assn., 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Emanuel U. Wallerstein, Professional Bldg., Richmond, Va.
Secretary: Dr. William R. Weisiger, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Martin H. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. T. J. Walthall, 728 Main Ave., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. W. F. Swett, 693 Sutter St., San Francisco.
Secretary: Dr. Robert C. Martin, 384 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul A. Remington, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Searle B. Marlow, State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. A. Harry Rubenstein, Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.